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**NOVEMBER 1956** **VOL. LI. NO. II**

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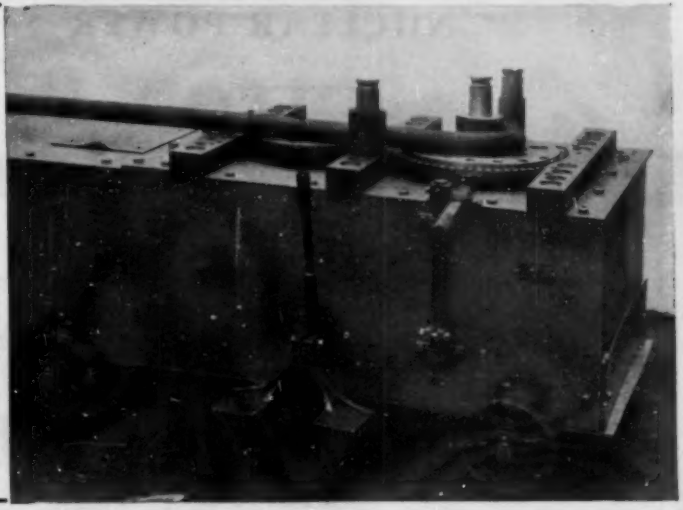

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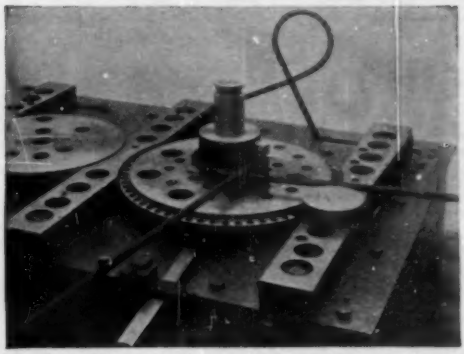

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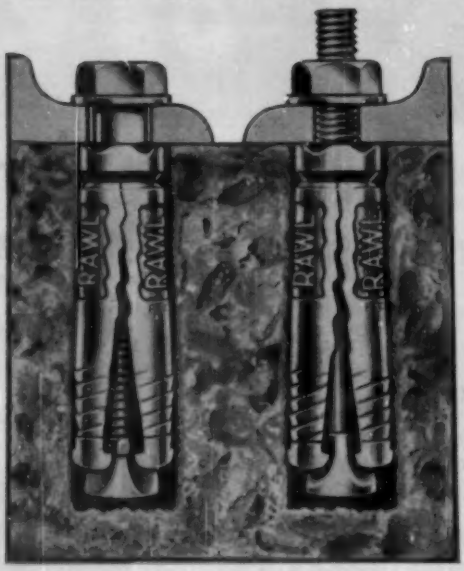


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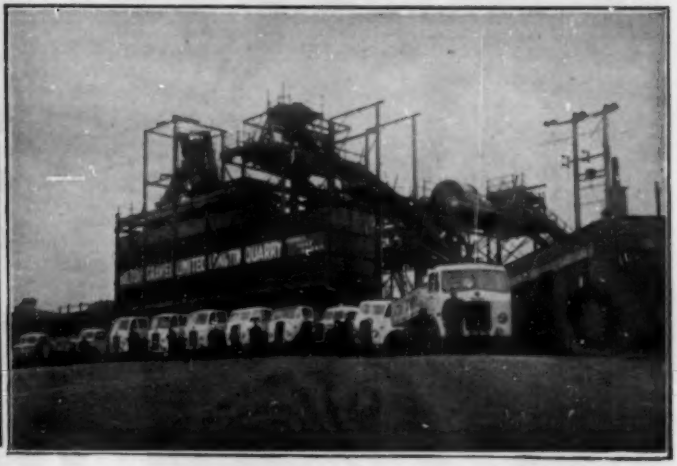

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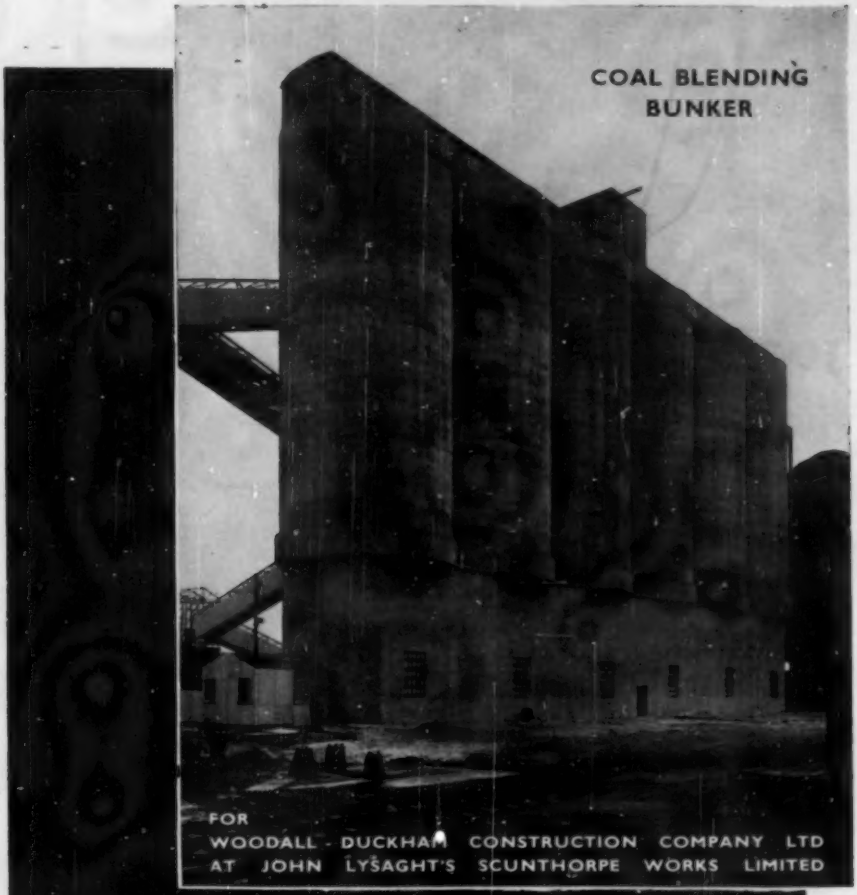


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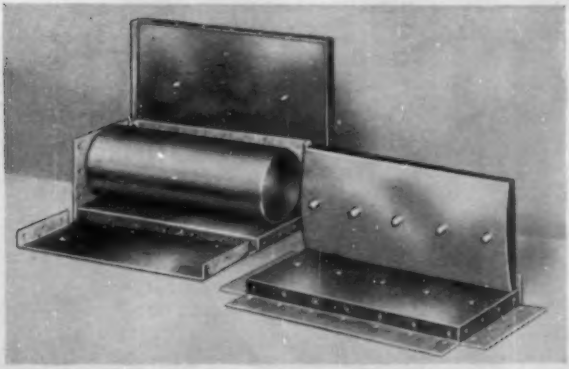

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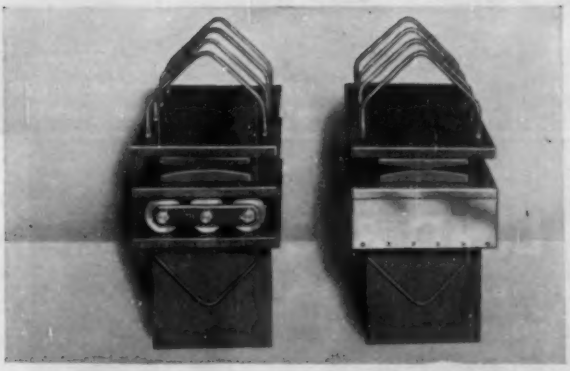

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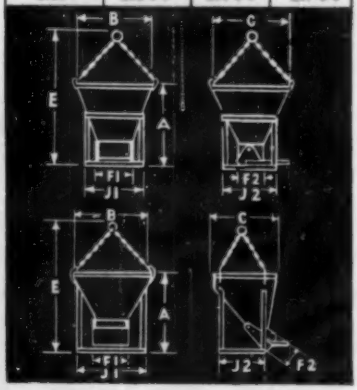


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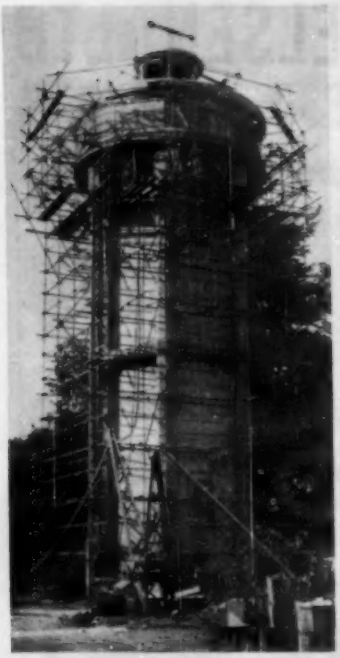

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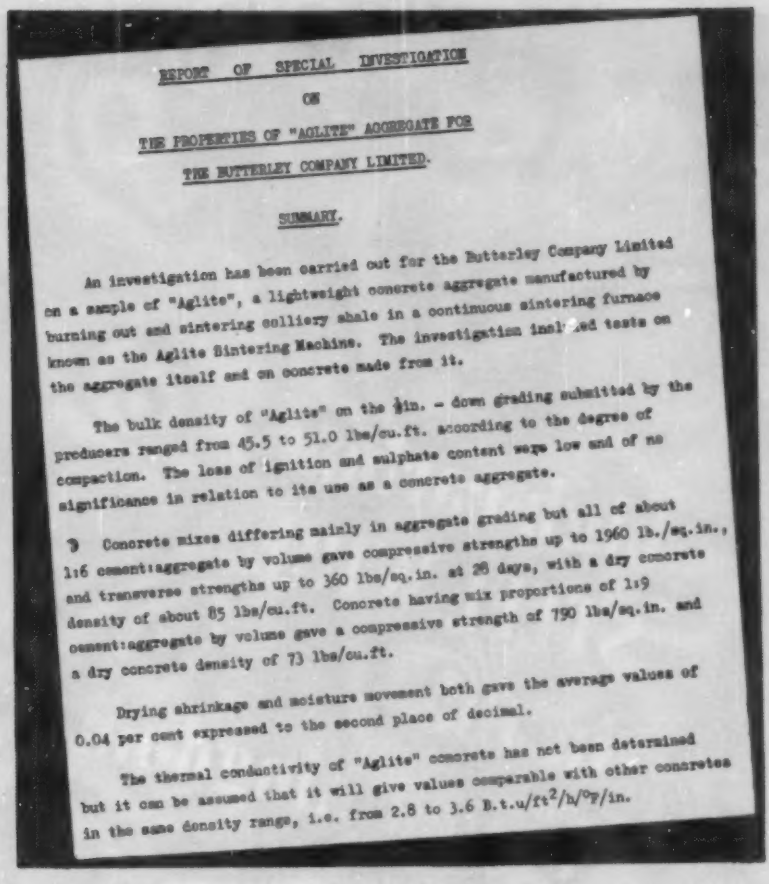

REPORT OF SPECIAL INVESTIGATION

ON

THE PROPERTIES OF "AGLITE" AGGREGATE FOR

THE BUTTERLEY COMPANY LIMITED.

SUMMARY.

An investigation has been carried out for the Butterley Company Limited on a sample of "Aglite", a lightweight concrete aggregate manufactured by burning out and sintering colliery shale in a continuous sintering furnace known as the Aglite Sintering Machine. The investigation included tests on the aggregate itself and on concrete made from it.

The bulk density of "Aglite" on the ¾in. - down grading submitted by the producers ranged from 45.5 to 51.0 lbs/cu.ft. according to the degree of compaction. The loss of ignition and sulphate content were low and of no significance in relation to its use as a concrete aggregate.

Concrete mixes differing mainly in aggregate grading but all of about 1:6 cement:aggregate by volume gave compressive strengths up to 1960 lb./sq.in., and transverse strengths up to 360 lbs/sq.in. at 28 days, with a dry concrete density of about 85 lbs/cu.ft. Concrete having mix proportions of 1:9 cement:aggregate by volume gave a compressive strength of 790 lbs/sq.in. and a dry concrete density of 73 lbs/cu.ft.

Drying shrinkage and moisture movement both gave the average values of 0.04 per cent expressed to the second place of decimal.

The thermal conductivity of "Aglite" concrete has not been determined but it can be assumed that it will give values comparable with other concretes in the same density range, i.e. from 2.8 to 3.6 B.t.u/ft$^2$/h/°F/in.


# Aglite: first test report . . .

*Report by The National Building Research Station on preliminary tests on Aglite.*

Tests continue on concrete mixes of "Aglite" and varying proportions of ordinary and rapid-hardening Portland cements.
The Building Research Station will report on these tests as soon as they are completed.

If you would care to receive the preliminary report shown above, we shall be pleased to send you a copy and, at the same time, answer any questions regarding the properties and capabilities of Butterley-"Aglite".

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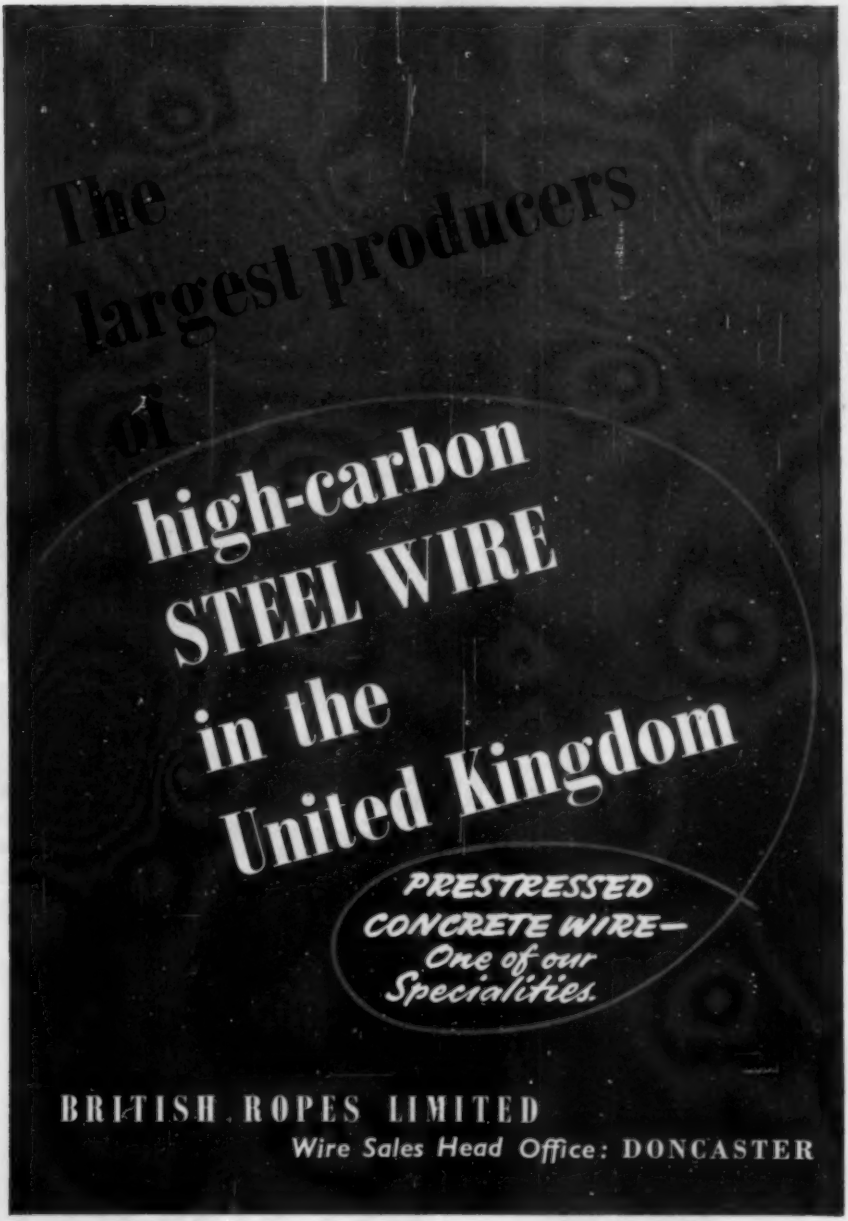
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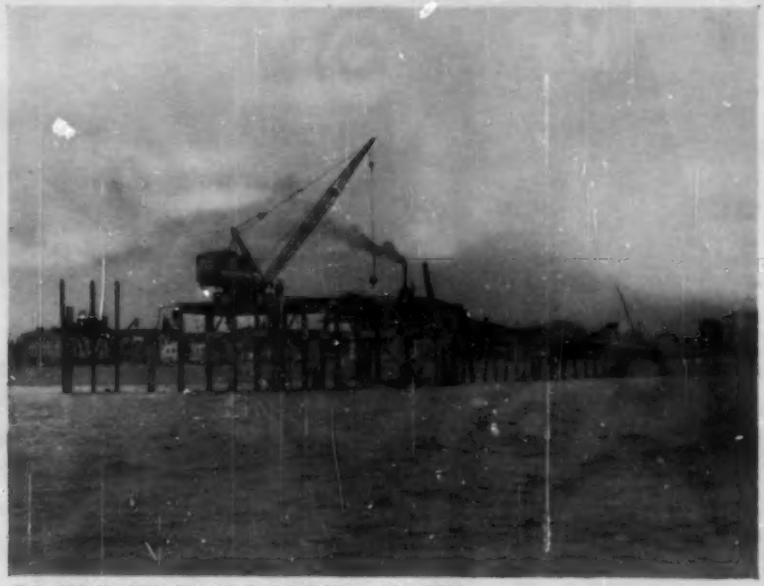

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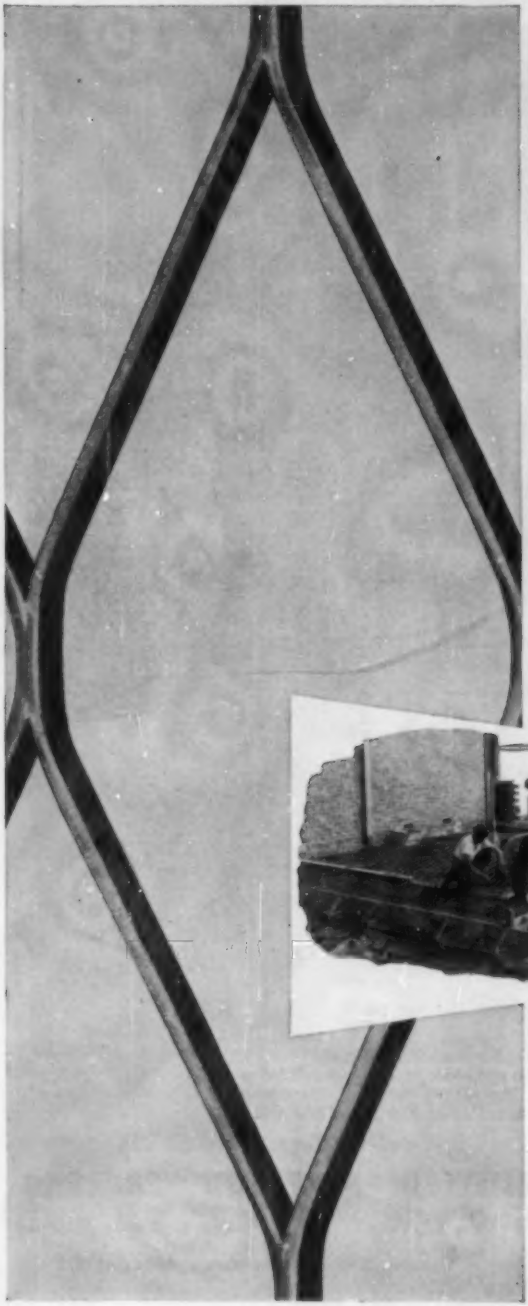

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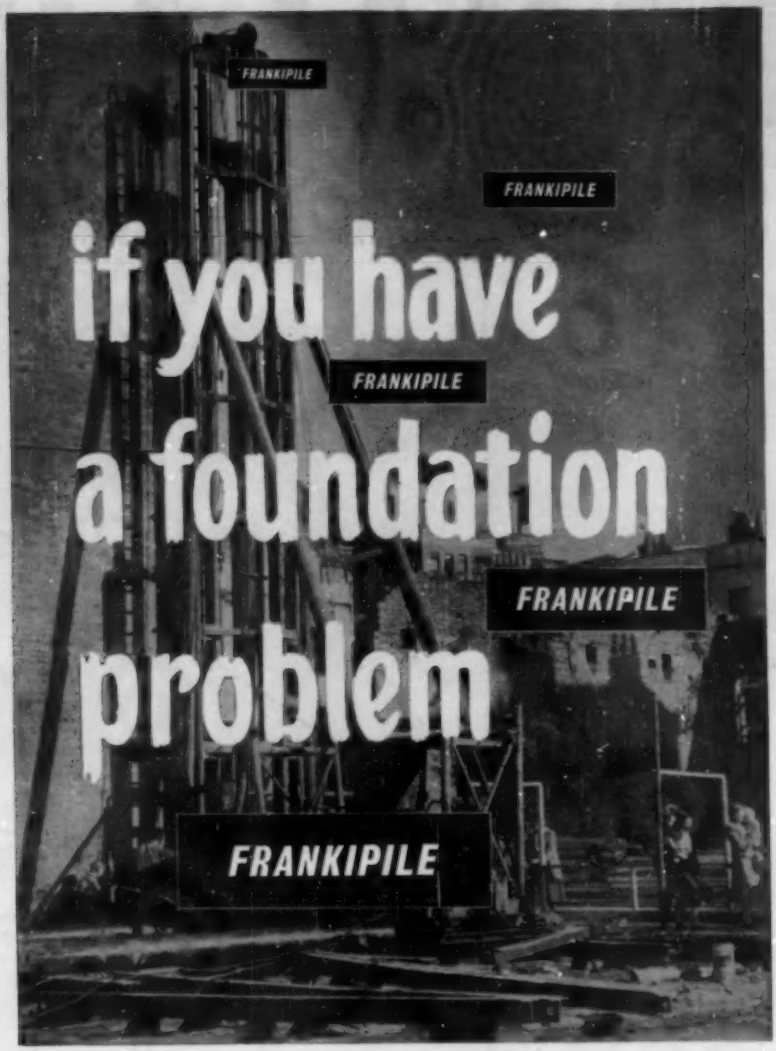


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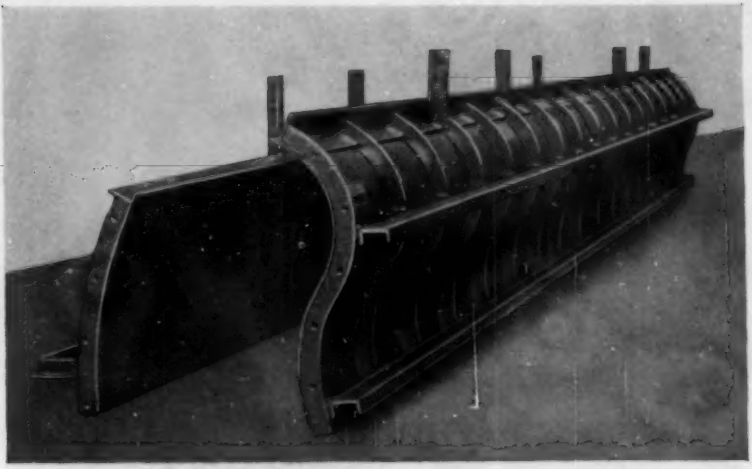

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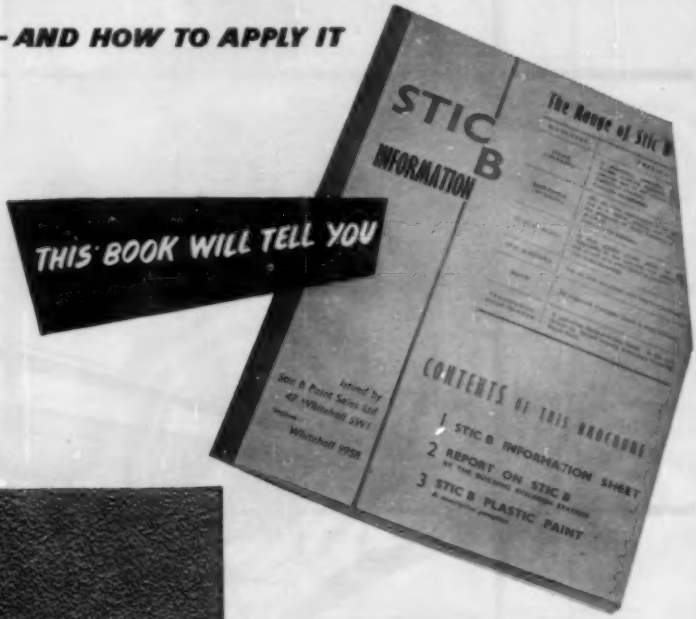
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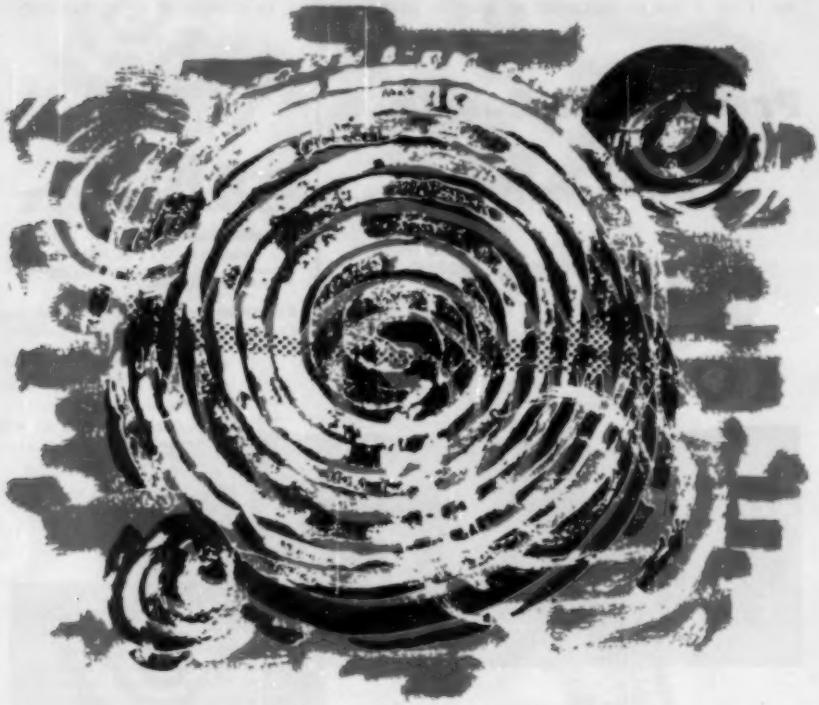

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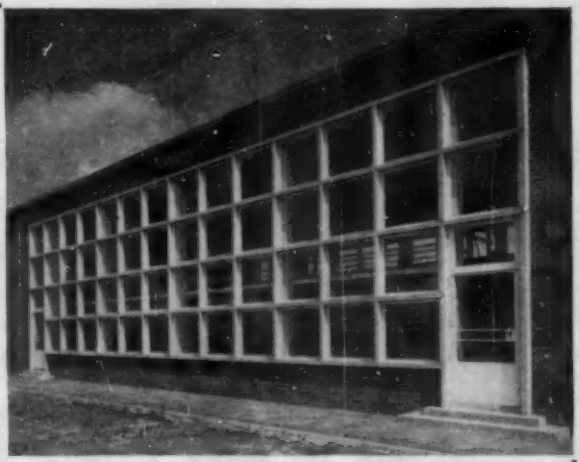

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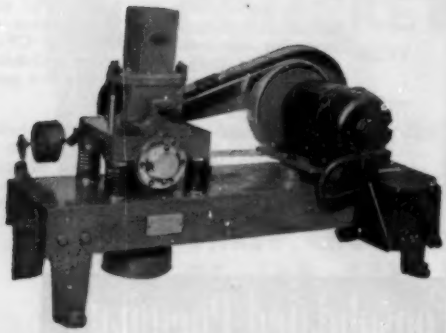

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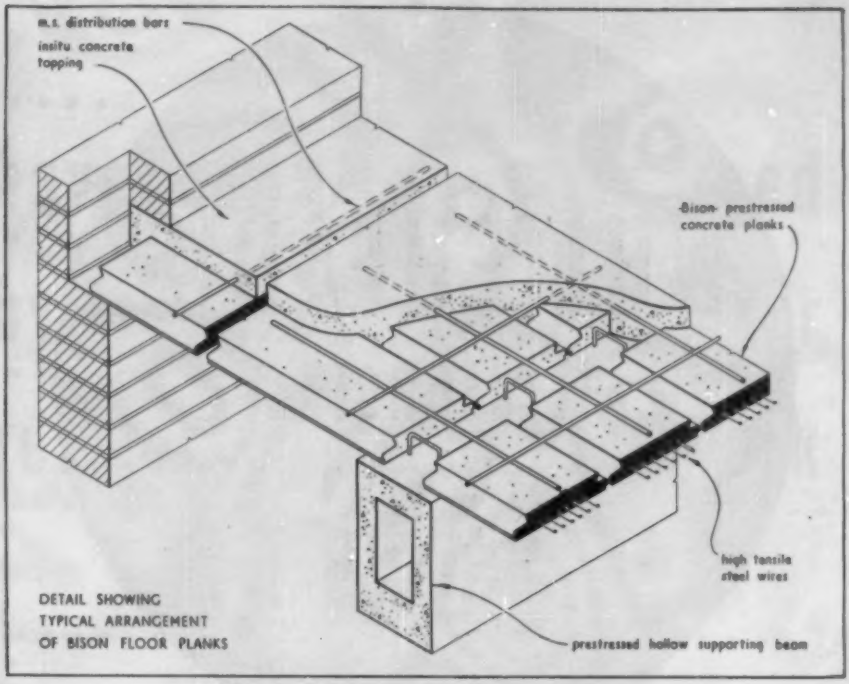


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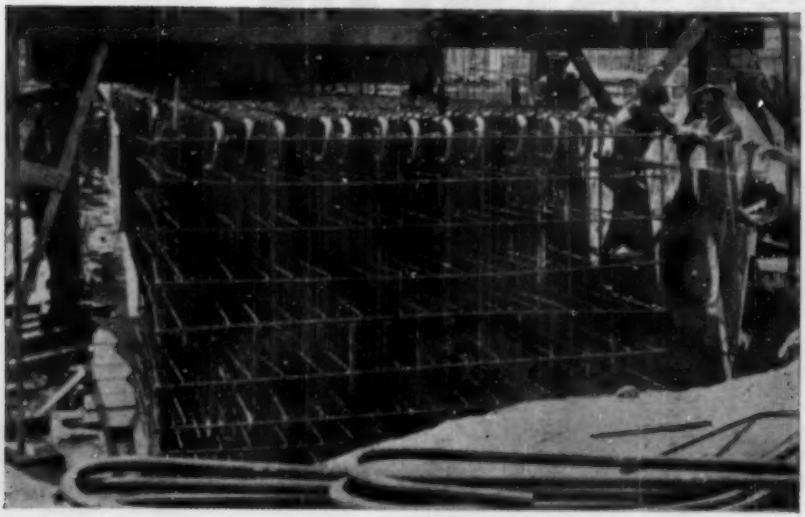

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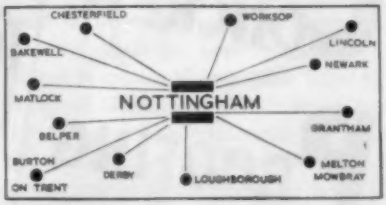


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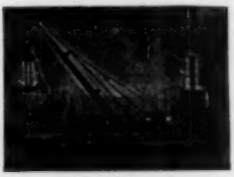

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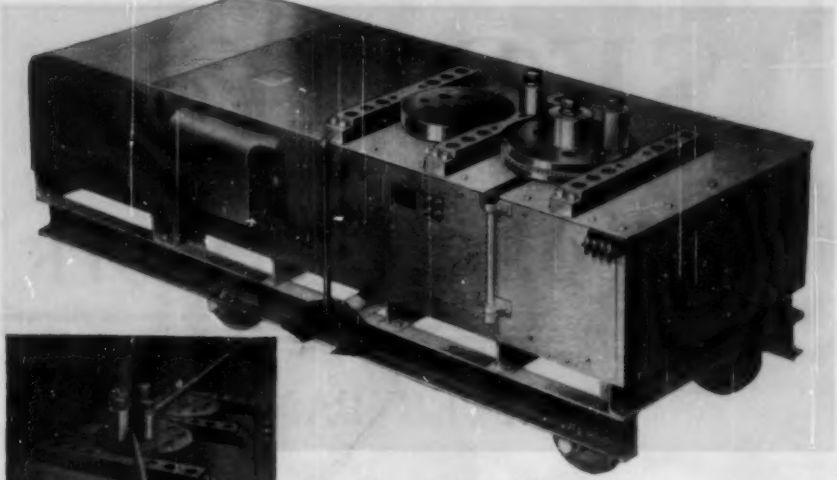

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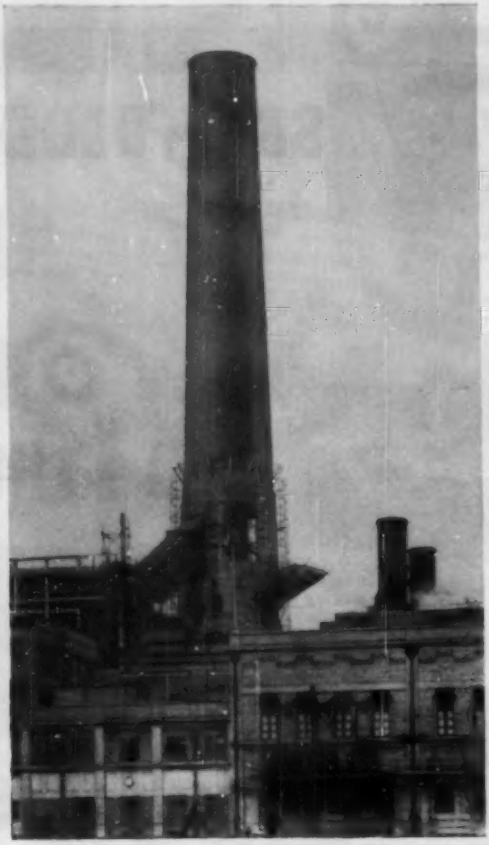

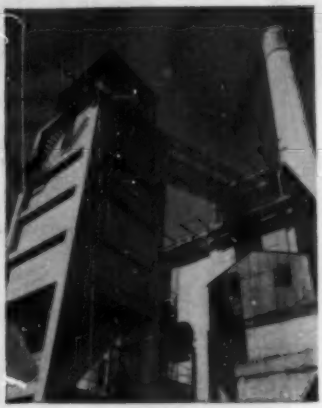

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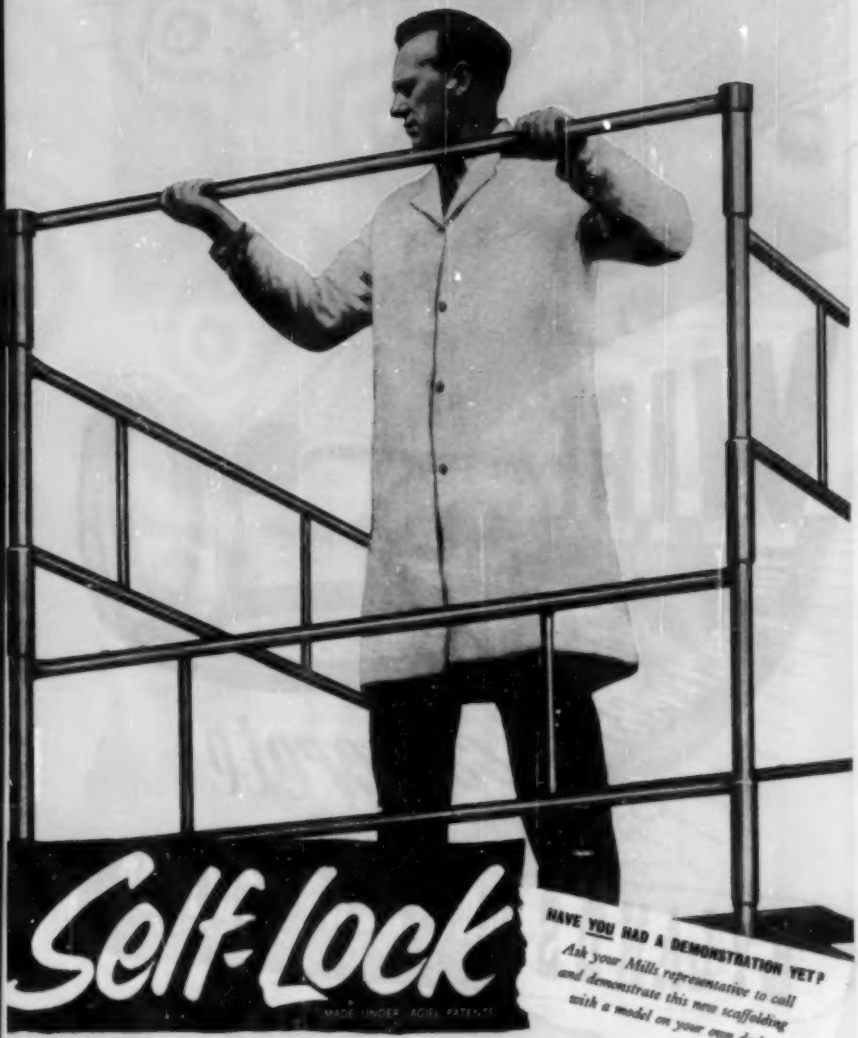

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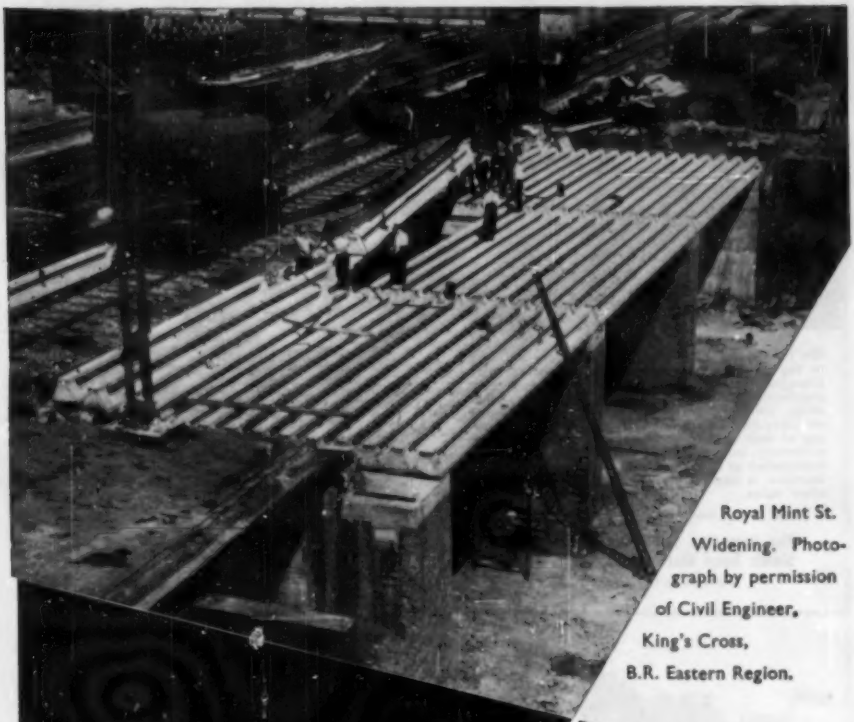

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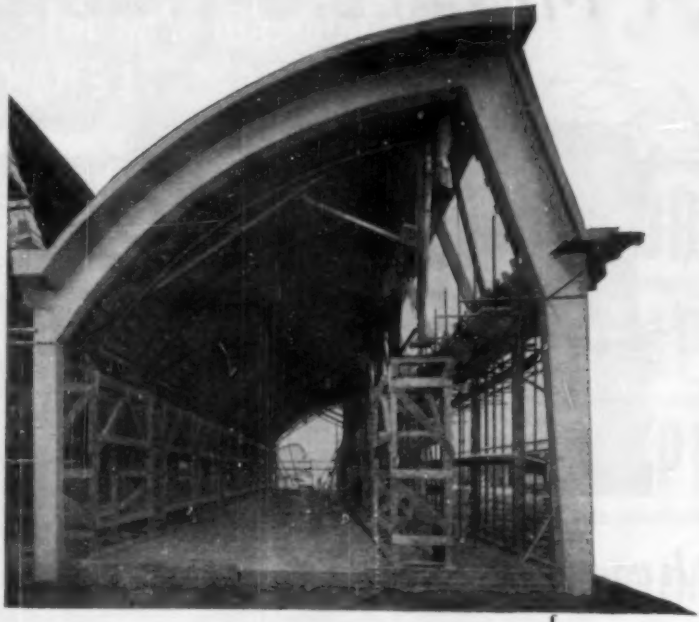

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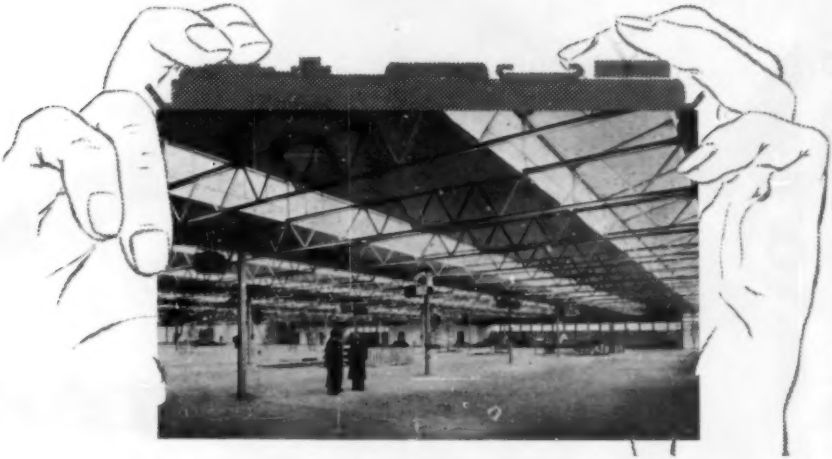

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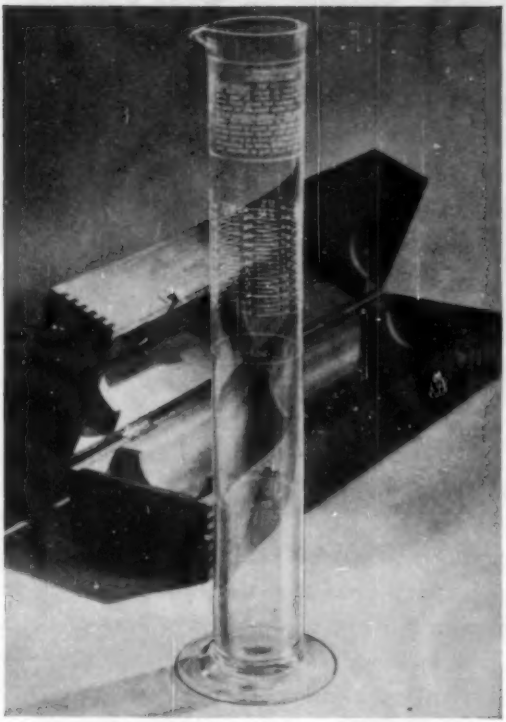

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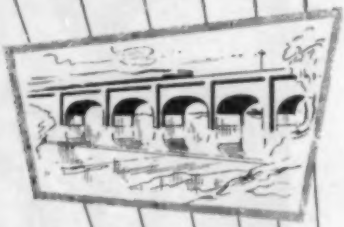

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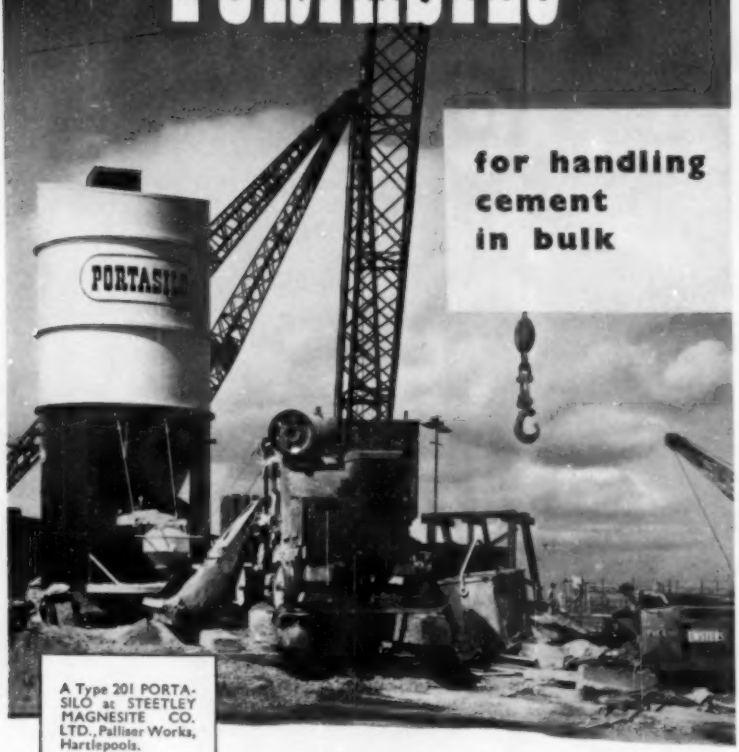


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Volume LI, No. 11. LONDON, NOVEMBER, 1956.


# EDITORIAL NOTES

## The Setting and Hardening of Portland Cement.

IT has been truly said that in natural phenomena we know the " how " of many things but that we know the " why " of nothing at all. In the case of adhesives there is no generally-accepted explanation even of the " how ", and what causes the wetted grains of cement to adhere together and form a solid is still not known. At the end of the last century Le Chatelier propounded the crystallisation theory : his view was that the compounds when wetted produced a super-saturated solution from which the hydrated compound quickly crystallised, that the liquid, being no longer saturated, redissolved more of the anhydrous compounds so that the mass progressively crystallised, and that the contact and entanglement of these crystals was the only cause of the solidity and strength of set cement. Thomas Edison in the U.S.A. and others preferred what they called the colloidal theory, and as the result of a great deal of research the Research Section of the American Portland Cement Association seem to have come to the conclusion that further research on these lines is most likely to result in a solution of the problem. This research was described recently at a lecture given in London (under the auspices of the Cement and Concrete Association) by Mr. T. C. Powers, Manager of the Basic Research Section of the American Portland Cement Association.

It is now well known that when a particle of cement is wetted a chemical reaction produces on its surface a new solid called gel that occupies more space than the cement that has reacted to form it, that is the particle of cement has increased in size and comprises a core of the original cement covered by the new compound. When all the cement in a cement paste has hydrated, however, there are still water-filled spaces in the mass ; the total volume of these spaces increases according to the proportion of water used in the paste, and this is, of course, the reason why cement and concrete mixed with a low ratio of water to cement is stronger than when a high ratio of water to cement is used. The density of the gel substance has been calculated to be 2·15 grammes per cubic centimetre and its porosity about 26 per cent. Its permeability to water under pressure is less than that of most natural stones. The gel substance is in size in the range of colloids, and it has been calculated that it has the very large surface area of 250 square metres per gramme ; the shape of the particles is not known. The density of cement paste varies with the amount of gel it contains. In a hardened cement

paste there are pores within the gel and capillary pores between the gel. Tests made during a long period have shown that the specific surface area of the gel has remained constant up to fourteen years, and that there is a constant heat of hydration per unit of combined water from one day to twelve years. This result, arrived at by new methods of investigation, is contrary to the ideas generally held that cements of different compositions hydrated at different rates.

So far as the strength of cement is concerned it is obvious that the most important factor is the volume of space occupied by the mixing water or that is filled with gel. This can to some extent be controlled in two ways, namely by keeping the cement wet while it is setting and so enabling as much as possible of each particle of cement to react and form solid gel, and by using less mixing water so that there will be less water-filled space to be filled by gel. This is another way of saying that the strongest cement and concrete is produced when the amount of mixing water is sufficient only to hydrate the cement and when the cement or concrete is kept moist during the hardening period. The conception of the formation of gel indicates that an excess of mixing water does not weaken the actual particles of cement, but that in the hardened cement paste the ratio of gel to total volume is less because an excess of water produces more capillary pores and thereby reduces the density.

Cement gel differs from some other gelatinous substances. For example, if gelatine is soaked in water it continues to swell until it has little or no hardness. Dry cement gel, on the other hand, when soaked swells only a microscopic amount and then stops swelling. In considering the physical properties of cement it is interesting also to compare it with clay, which is also composed of colloids. Dry clay is a solid, and its strength varies according to its water content. The physical forces between the grains tend to bind it together. If it is saturated with water clay will completely disintegrate and separate into its component particles, and if these particles are nearly dried and squeezed together they will again form a solid when the mass is dry. Because washing with water will not separate the particles in hardened cement paste, it is assumed that in this case chemical as well as physical bonds must be present to hold the particles together. Whether or not this is so is not known. According to Mr. Powers the volume of gel produced per unit volume of cement consumed in making it is about 2, that is one cubic inch of Portland cement increases in volume to about two cubic inches when it is hydrated, but it is not likely that pressure of gel against gel is sufficient to produce the great strength associated with Portland cement. It is obvious that many of the properties of concrete are influenced by the volume of gel in a given volume of cement paste, because this is a criterion of its qualities as a binding material, and Mr. Powers is of the opinion that the distribution of water between the gel and the capillary pores is a function of temperature and pressure, and that the movement of this water when concrete is subjected to stress is one of the causes of " creep " of concrete.

It is well known that hardened cement and concrete are stronger when they are in a dry state than when they are wet. This is because the gel loses strength if it expands only a small amount. Yet we have the unexplained fact that a plain concrete beam subjected to a bending test may be stronger when wet than when dry ; it is thought that this may be due to the presence of tensile stresses in parts of the specimen due to uneven drying.

# Bending and Axial Stresses in Hollow Circular Columns.

By R. J. BARTLETT, A.M.I.Struct.E.

THE stresses in a hollow circular reinforced concrete column subjected to an axial load $W$ and a bending moment $M$ causing tension may be calculated by considering equivalent solid members which, with axial loads $W_1$ and $W_2$ and bending moments $M_1$ and $M_2$, produce stresses in the concrete similar to those in the hollow member. It is assumed that the reinforcement consists of an even number of bars symmetrically disposed about the centre of the section. The section shown in *Fig.* 1 (b) is equivalent to the difference between the two hypothetical sections (a) and (c), in each of which the reinforcement is on the circumference.

Eccentricities $e_1D_1$ and $e_2D_2$ must be calculated for sections (a) and (c) such that the neutral axes are at the same distances from their centres as in section (b). Then, for section (a) only, with the load $W_1$ and eccentricity $e_1D_1$, the maximum stress in the concrete will be the same as that in section (b).

The percentages of reinforcement $r_1$ and $r_2$ for sections (a) and (c) are $r\left(d^2 - \frac{1}{q^2}\right)$ and $rq^2(d^2 - 1)$ respectively, where $r$ is the percentage of reinforcement in section (b), $q$ is $\frac{D_1}{D_2}$, and $d$ the ratio of the diameter of the circle on which the actual reinforcement lies to $D_1$. This ratio for the reinforcement in sections (a) and (c) is always unity.

If the reinforcement in section (b) is in two rings, then

$$r_1 = r_i\left(d_i^2 - \frac{1}{q^2}\right) + r_o\left(d_o^2 - \frac{1}{q^2}\right); \quad r_2 = r_iq^2(d_i^2 - 1) + r_oq^2(d_o^2 - 1),$$

where $r_i$ and $r_o$ are the percentages of reinforcement in the inner and outer rings with diameter ratios $d_i$ and $d_o$ respectively. The value of $e_1$ is between $\frac{K}{q^3 - 1}$ and $\frac{K}{q^3}$

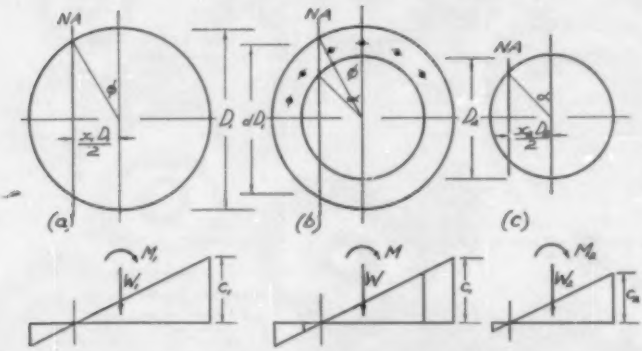
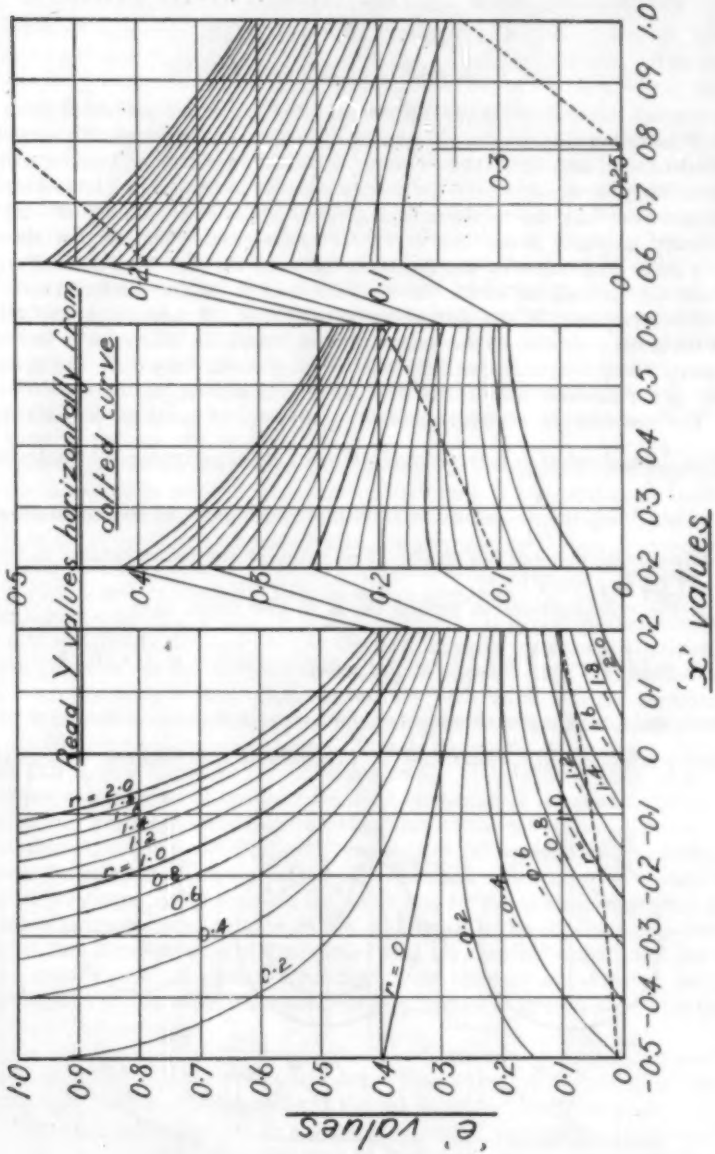



**Fig. 1.**


Read Y values horizontally from dotted curve
'x' values
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GRAPH I.

## GRADING OF AGGREGATES

A knowledge of the reasons for grading concrete aggregates, why different gradings are required for different classes of work, the effect on concrete of the shape of the particles, and so on, will help the supplier of aggregates to understand the requirements of the customer.

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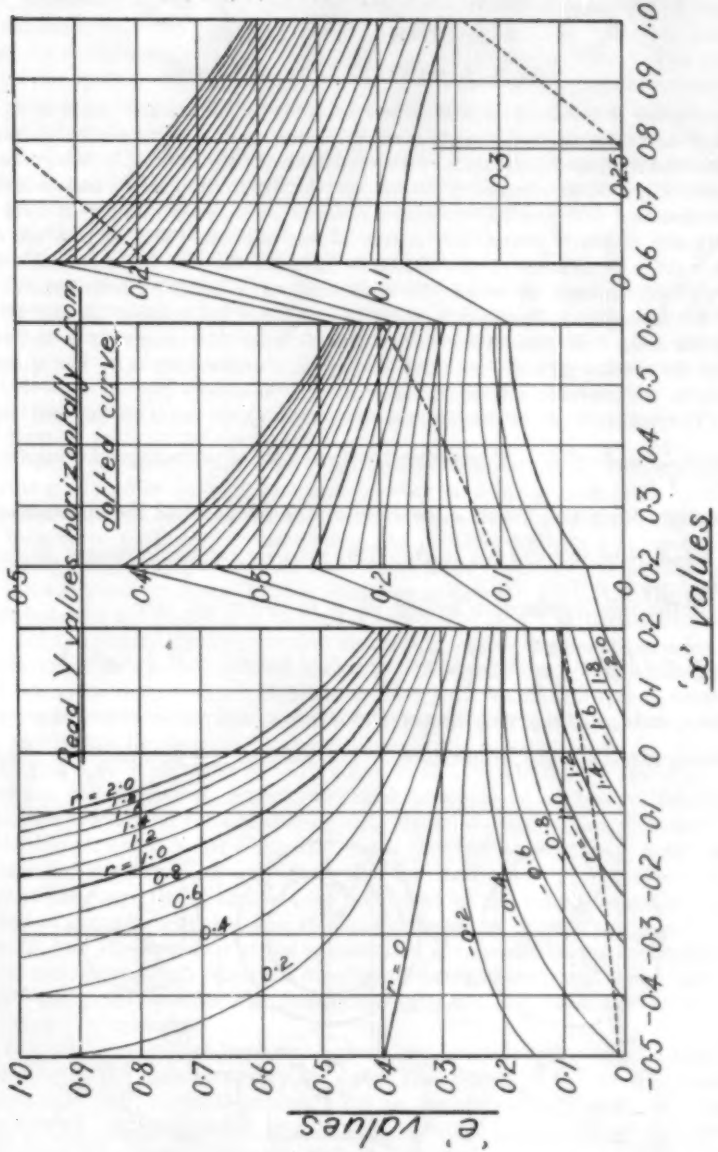
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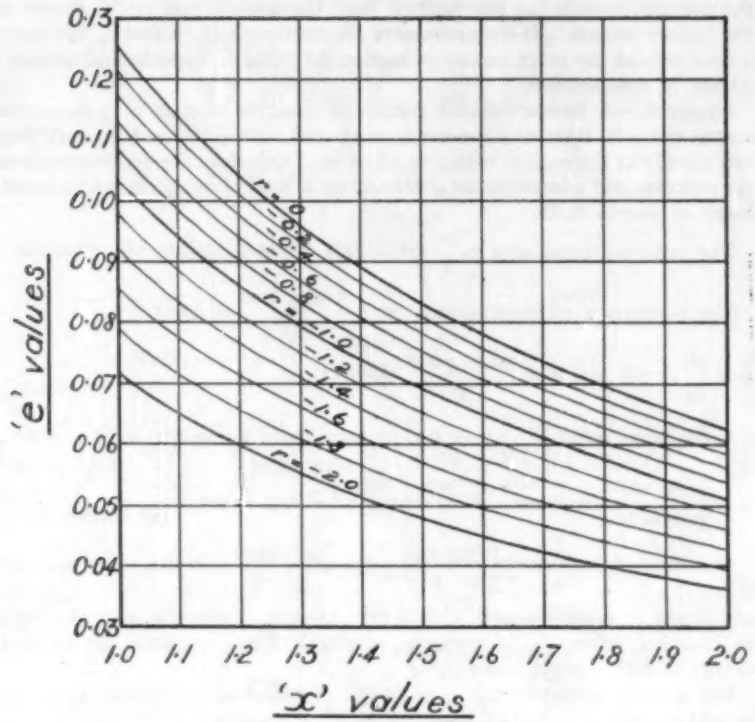
GRAPH I.

GRAPH II.




(normally nearer the former) where $K = e(q^3 - q)$ and $e$ is the eccentricity factor for section (b) and is $\frac{M}{WD_1}$.

A trial value of $e_1$ is selected and adjusted by using *Graphs* I and II to obtain values of $x_1$, $x_2$, $e_1$, and $e_2$ which satisfy the relationships

$$x_2 = qx_1 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

and

$$e_2 = q^3 e_1 - K \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

The maximum stress in the concrete is

$$c = \frac{4W(1 + x_1)}{(D_1^2 - D_2^2)(10Y + 0{\cdot}471r_1x_1)} \quad . \quad . \quad . \quad (3)$$

where $Y$ is a function of $x$ and is obtained from *Graph* I.

The maximum stress in the reinforcement in section (b) is given by

$$t = \frac{cm(d\cos\theta - x_1)}{1 + x_1} \quad . \quad . \quad . \quad . \quad . \quad (4)$$

in which $\theta$ is the angle between the plane of the bending moment and the diameter of the column through the bar farthest from the neutral axis in the tensile side of the hollow section. If it is necessary to use *Graph* II to find $e_2$, the neutral axis does not cut the inner surface of section (b); that is, hypothetical section (c) is wholly in compression.

EXAMPLE.—A hollow circular reinforced concrete column of 3 ft. external diameter and 2 ft. internal diameter is reinforced with eighteen $\frac{3}{4}$-in. bars placed symmetrically in the section with 2 in. of cover. Calculate the maximum stresses in the concrete and reinforcement due to an axial load of 90,000 lb. and a bending moment of 80,000 ft.-lb.

The cross-sectional area is $\frac{\pi}{4}(36^2 - 24^2) = 566$ sq. in.

The percentage of reinforcement $r$ is $\frac{5{\cdot}52 \times 100}{566} = 0{\cdot}975$.

$$q = \frac{36}{24} = 1{\cdot}5 \text{ and } d = \frac{36 - 4{\cdot}625}{36} = 0{\cdot}871.$$

$$r_1 = 0{\cdot}975\left(0{\cdot}871^2 - \frac{1}{1{\cdot}5^2}\right) = 0{\cdot}307. \quad r_2 = 0{\cdot}975 \times 1{\cdot}5^2(0{\cdot}871^2 - 1) = -0{\cdot}524.$$

$$e = \frac{80{,}000}{90{,}000 \times 3} = 0{\cdot}296. \quad K = 0{\cdot}296(1{\cdot}5^3 - 1{\cdot}5) = 0{\cdot}555.$$

The limits for $e_1$ are $\frac{0{\cdot}555}{1{\cdot}5^3 - 1} = 0{\cdot}234$ and $\frac{0{\cdot}555}{1{\cdot}5^3} = 0{\cdot}164$. Try $e_1 = 0{\cdot}21$.

From *Graph* I, when $r = 0{\cdot}3$, $x_1 = 0{\cdot}52$. Then $x_2 = 1{\cdot}5 \times x_1 = 0{\cdot}78$. Again, from *Graph* I, when $r = -0{\cdot}524$, $e_2 = 0{\cdot}143$. Using equation (2) to check, $e_2 = 0{\cdot}21 \times 1{\cdot}5^3 - 0{\cdot}555 = 0{\cdot}154$.

For greater accuracy try $e_1 = 0{\cdot}205$. Proceeding as before, $x_1 = 0{\cdot}545$, $x_2 = 0{\cdot}8175$, and $e_2 = 0{\cdot}137$; also $Y = 0{\cdot}18$. Checking:

$$e_2 = 0{\cdot}205 \times 1{\cdot}5^3 - 0{\cdot}555 = 0{\cdot}137.$$

Thus

$$c = \frac{4 \times 90{,}000 \times 1{\cdot}545}{(36^2 - 24^2)(1{\cdot}8 + 0{\cdot}471 \times 0{\cdot}307 \times 0{\cdot}545)} = 412 \text{ lb. per sq. in.}$$

and $$t = \frac{412 \times 15(0{\cdot}871 - 0{\cdot}545)}{1{\cdot}545} = 1300 \text{ lb. per sq. in.}$$

## Appendix.

The following should be read in conjunction with the article on circular columns on p. 293 of this journal for August, 1955. By using suffices 1 and 2 for the symbols relating to the outer and inner circumferences of the section, and noting that $r$ now indicates a percentage of reinforcement, expression (5) becomes

$$W = \frac{D_1^2 c_1 Y_1 + \frac{r}{100}(D_1^2 - D_2^2)\pi m c_1 \sin\phi}{4(1 + \sin\phi)} - \frac{D_2^2 c_2 Y_2}{4(1 + \sin\alpha)}.$$

The geometry of section (b) and the diagram of the variation of stress establishes that

$$x_2 = qx_1,\ \sin\phi = x_1 \text{ and } \sin\alpha = x_2,$$

and

$$c_2 = \frac{c_1(1 + q\sin\phi)}{q(1 + \sin\phi)} = \frac{c_1(1 + qx_1)}{q(1 + x_1)}.$$

Therefore

$$W = \frac{D_1^2 c_1\left[Y_1 - \frac{Y_2}{q^3} + \frac{r}{100}\left(1 - \frac{1}{q^2}\right)\pi m x_1\right]}{4(1 + x_1)} \quad . \quad . \quad . \quad (5a)$$

Similarly, (6) and (7) become

$$WeD_1 = \frac{D_1^3 c_1\left[\frac{X_1}{24} - \frac{X_2}{24q^4} + \frac{r}{100}\frac{\left(1 - \frac{1}{q^2}\right)\pi m d^2}{4}\right]}{4(1 + x_1)} \quad . \quad . \quad (6a)$$

and

$$\left[Y_1 - \frac{Y_2}{q^3} + \frac{r}{100}\left(1 - \frac{1}{q^2}\right)\pi m x_1\right]e = \frac{X_1}{24} - \frac{X_2}{24q^4} + \frac{r}{100}\frac{\left(1 - \frac{1}{q^2}\right)\pi m d^2}{4} \quad . \quad (7a)$$

For section (a)

$$W_1 = \frac{D_1^2 c_1\left[Y_1 + \frac{r}{100}\left(d^2 - \frac{1}{q^2}\right)\pi m x_1\right]}{4(1 + x_1)} \quad . \quad . \quad . \quad (5b)$$

$$W_1 e_1 D_1 = \frac{D_1^3 c_1\left[\frac{X_1}{24} + \frac{r}{100}\frac{\left(d^2 - \frac{1}{q^2}\right)\pi m}{4}\right]}{4(1 + x_1)} \quad . \quad . \quad . \quad (6b)$$

and

$$\left[Y_1 + \frac{r}{100}\left(d^2 - \frac{1}{q^2}\right)\pi m x_1\right]e_1 = \frac{X_1}{24} + \frac{r}{100}\frac{\left(d^2 - \frac{1}{q^2}\right)\pi m}{4} \quad . \quad . \quad (7b)$$

For section (c)

$$W_2 = \frac{D_2^2 c_2\left[Y_2 + \frac{r}{100}q^2(d^2 - 1)\pi m x_2\right]}{4(1 + x_2)}$$

$$= \frac{D_1^2}{q^2} \times \frac{c_1(1 + qx_1)}{q(1 + x_1)} \times \frac{\left[Y_2 + \frac{r}{100}q^2(d^2 - 1)\pi m q x_1\right]}{4(1 + qx_1)}.$$

By substituting for $D_2$, $c_2$, and $x_2$, this becomes

$$\frac{D_1^2 c_1\left[\frac{Y_2}{q^3} + \frac{r}{100}(d^2 - 1)\pi m x_1\right]}{4(1 + x_1)} \quad . \quad . \quad . \quad . \quad (5c)$$

$$W_2e_2D_2 = \frac{D_2{}^3c_2\left[\frac{X_2}{24} + \frac{r}{100}\frac{q^2(d^2-1)\pi m}{4}\right]}{4(1+x_2)} = \frac{D_1{}^3c_1\left[\frac{X_2}{24q^4} + \frac{r}{100}\frac{(d^2-1)\pi m}{4q^2}\right]}{4(1+x_2)} \quad (6c)$$

and $$\left[Y_2 + \frac{r}{100}q^2(d^2-1)\pi m x_2\right]e_2 = \frac{X_2}{24} + \frac{r}{100}\frac{q^2(d^2-1)\pi m}{4}.$$

That is, by dividing throughout by $q^4$,

$$\left[\frac{Y_2}{q^3} + \frac{r}{100}(d^2-1)\pi m x_1\right]\frac{e_2}{q} = \frac{X_2}{24q^4} + \frac{r}{100}\frac{(d^2-1)\pi m}{4q^2} \quad . \quad (7c)$$

From (5*b*) and (5*c*),

$$W_1 - W_2 = \frac{D_1{}^2c_1\left[Y_1 - \frac{Y_2}{q^3} + \frac{r}{100}\left(1 - \frac{1}{q^2}\right)\pi m x_1\right]}{4(1+x_1)} = W \text{ [from (5}a\text{)]}$$

From (6*b*), (6c), and (6*a*),

$$W_1e_1D_1 - W_2e_2D_2 = \frac{D_1{}^3c_1\left[\frac{X_1}{24} - \frac{X_2}{24q^4} + \frac{r}{100}\frac{\left(1 - \frac{1}{q^2}\right)\pi m d^2}{4}\right]}{4(1+x_1)} = WeD_1.$$

Expressions (7b) and (7c) give the relationship

$$\left[Y_1 + \frac{r}{100}\left(d^2 - \frac{1}{q^2}\right)\pi m x_1\right]e_1 - \left[\frac{Y_2}{q^3} + \frac{r}{100}(d^2-1)\pi m x_1\right]\frac{e_2}{q}$$

$$= \frac{X_1}{24} - \frac{X_2}{24q^4} + \frac{r}{100}\frac{\left(1 - \frac{1}{q^2}\right)\pi m d^2}{4} \quad . \quad (8)$$

Since $$W_1e_1 - W_2\frac{e_2}{q} = We \quad . \quad . \quad . \quad . \quad (9)$$

and the right-hand sides of equations (7a) and (8) are identical, it follows that the same results are obtained for sections (a) and (b).

If $W$, $W_1$, and $W_2$ are proportional to their respective cross-sectional areas, equation (2) is obtained by substituting in (9). The limits $\frac{K}{q^3-1}$ and $\frac{K}{q^3}$ for $e_1$ would occur when $e_2 = e_1$, and $e_2 = 0$ in (2). Equations (7b) and (7c) expressing the relationship between eccentricity factors and $x$ for sections (a) and (c) are represented by *Graphs* I and II for percentages of reinforcement applicable only to such hypothetical sections.

The expression $\frac{3}{4}\cos\phi + \left(\frac{\pi}{2} + \phi\right)\sin\phi - \frac{\cos 3\phi}{12}$ for $Y$

becomes $$\frac{(2+x^2)}{3}\sqrt{1-x^2} + x\sin^{-1}x + \frac{\pi x}{2}$$

by substituting $x$ for $\sin\phi$ and is shown in *Graph* I.

If the neutral axis does not cut the inner surface of section (b), then section (c) is completely in compression. In this case $x$ expresses no trigonometrical relation-

ship but remains the ratio of the distance between the neutral axis and the centre to $\frac{D_2}{2}$. The equivalent area and section modulus of section (c) are

$$\frac{\pi D_2^2}{4}\left(1+\frac{r_2}{100}m\right) \text{ and } \frac{\pi D_2^3}{32}\left(1+2\frac{r_2}{100}m\right)$$

respectively. By using the usual expression $\frac{W}{A} \pm \frac{M}{Z}$ for the stresses, the relationship between $e_2$ and $x_2$ is established as

$$e_2 x_2 = \frac{1+0{\cdot}3\frac{r_2}{100}}{8\left(1+0{\cdot}15\frac{r_2}{100}\right)} \quad . \quad . \quad . \quad . \quad (10)$$

This is represented in *Graph* II for the appropriate range of values of $r$. A modular ratio of 15 is assumed throughout.

## The Cost of Multiple-story Buildings.

MR. W. E. J. BUDGEN, B.Sc., M.I.C.E., writes as follows.

The article in your October number by Mr. O. N. Arup, C.B.E., and the report of the Building Research Station, dealing with the cost of multiple-story buildings both assume that "cross-wall" construction using reinforced concrete walls is cheaper than a normal reinforced concrete frame. It may be, however, that residential flats planned to suit cross-wall construction but with the walls, particularly in the upper stories, replaced by beams and columns and divided by partitions would be even cheaper.

Cross-wall construction imposes a discipline on the planner so that, generally, the spans of slabs are relatively short, loads are carried directly to their supports, and also there is a great amount of repetition. All these lead to economy in structure, but it does not follow that the most economical solution of cross-wall planning is the use of reinforced concrete cross walls. For lower buildings, brick walls, as the report says, may be the best solution. For higher buildings, beams and columns, which need to be very little thicker than the walls, together with infilling partitions where required, may often result in more economical construction. Further, the partitions, which in the upper stories will be a large proportion of the cross walls, may have advantages as regards sound proofing, thermal conductivity, and so on; they will nearly always be cheaper than reinforced concrete walls.

Generally speaking it is not economical for vertical structural members to be of the same cross section through many stories unless the waste of material in the upper part is balanced by a saving in shuttering throughout. But similar saving in the cost of shuttering may also be achieved by repetition of column sizes and this, together with variations of the reinforcement in the columns, can also result in the economical use of concrete.

In conclusion it must be emphasised that, while economy of construction is obviously important, it must not involve too severe a discipline on the planner to the extent of rendering the flats unsuitable for their main purpose.

# Book Reviews.

**"The Chemistry of Cement and Concrete."** By F. M. Lea, C.B.E. [London: Edward Arnold (Publishers), Ltd. Price 70s.]

THIS is a new edition of a book first published in 1935 under the joint authorship of Dr. Lea and Dr. Desch, and has now been revised by Dr. Lea. The chemist is concerned only with the cement content of concrete and with aggregates, generally artificial, that may have a harmful effect on cement, and to concrete exposed to harmful liquids or substances. The book is therefore chiefly of interest to cement makers and chemists. There are chapters on concrete aggregates and on the resistance of concrete to chemical attack and to sea-water, but these seem to contain little new information.

**"Design of Reinforced Concrete."** By B. W. Boguslavsky. (New York and London: The Macmillan Company. 1956. Price 42s.)

THE author states that his intentions were to present the fundamentals of structural theory applied to reinforced concrete so that the book would be useful for students, and to give also sufficient information for it to be useful to practising engineers. The first of these intentions has been realised, but it is doubtful if those engaged in design will find the book sufficiently comprehensive. The contents and arrangement are those common in American text-books, that is, a short chapter on materials, the principles of structural analysis, the theory of reinforced concrete beams and columns, and the design of flat slabs, retaining walls, foundations, and bridge arches. There are chapters on prestressed concrete, a shortened method of moment-distribution which is useful, and an example of a three-story building. There is no mention of ultimate-load theories. Cumbersome equations are derived to enable a beam to be designed without having to guess its weight initially, but this problem presents little difficulty after one has designed a few beams. The examples of calculations are clearly set out in tabular form, but generally they are not illustrated by details of reinforcement. The notes on prestressed concrete are brief but clearly written and are a good introduction to the subject. Throughout the book the sizes of bars are indicated by the number of eighths of an inch in the diameter, thus a $\frac{3}{4}$-in. bar is called a No. 6 bar, a $1\frac{1}{4}$-in. bar a No. 10 bar, and so on. It would be interesting to learn what purpose this system serves. —J. E. G.

**"Silos: Traité théorique et pratique."** By Marcel and André Reimbert. (Paris: Editions Eyrolles. 1956. Price 2900 francs.)

IT is seldom that particular types of structures are so thoroughly reviewed as they are in this book on silos. Every aspect of the subject is dealt with, including the calculation of pressures and loads; determination of sizes of members in timber, steel, and reinforced concrete; constructional details, drawings and photographs of work constructed; descriptions of shuttering including sliding shutters; and descriptions of tests on full-size silos and on models to determine the pressures due to various materials. Worked examples of the design of steel and concrete silos are given.

As a result of many measurements of the strains in the walls of full-size steel silos, the authors some years ago evolved a new theory for the calculation of horizontal pressures, and also investigated the dynamic increases of pressure that occur on filling and emptying a silo (details of the tests and theory were given in this journal for April, 1955). It might have been useful to include other theories of pressures, such as those due to Jansen and Airey, although the authors' methods appear to have gained considerable acceptance in France after an investigation by a technical committee of the Chambre Syndicale des Constructeurs en Ciment Armé. The book is thoroughly recommended.—J. E. G.

**"Stability Functions for Structural Frameworks."** By R. K. Livesley and D. B. Chandler. (Manchester: The University Press. 1956. Price 6s.)

THE effects of axial loads on the bending moments on members of a rigid frame may be calculated by an extension of the method of moment-distribution if the stiffnesses and carry-over factors for the members are calculated as functions of the axial loads on the members. The authors have computed values of certain functions which simplify these calculations, and have tabulated them in this booklet with examples of their use.

# The New Langstone Bridge, Hampshire.

A PRESTRESSED and reinforced concrete bridge, designed for full Ministry of Transport loading, has recently been completed to replace the old wooden Langstone bridge connecting Hayling Island with the mainland. The bridge (*Fig.* 2) is 958 ft. long and the approaches 2542 ft. long. The overall width is 34 ft. and there are a single carriageway 22 ft. wide and two footpaths each 5 ft. wide. The height at the centre is +18·46 ft. O.D.

The base of the approach embankments at each end of the bridge consists of quarry waste 1 ft. thick with layers of consolidated hard filling above it. Protection at the toe is provided by prestressed concrete sheet piling, and elsewhere by clay puddle and concrete pitching blocks 1 ft. by 2 ft. by 6 in. thick sealed with bitumen. The slope of the sides is generally 1 in 1½, except in the case of one side at the landward end where the slope is 1 in 6 to provide mooring facilities.

The bridge consists of a deck of prestressed beams carried on reinforced

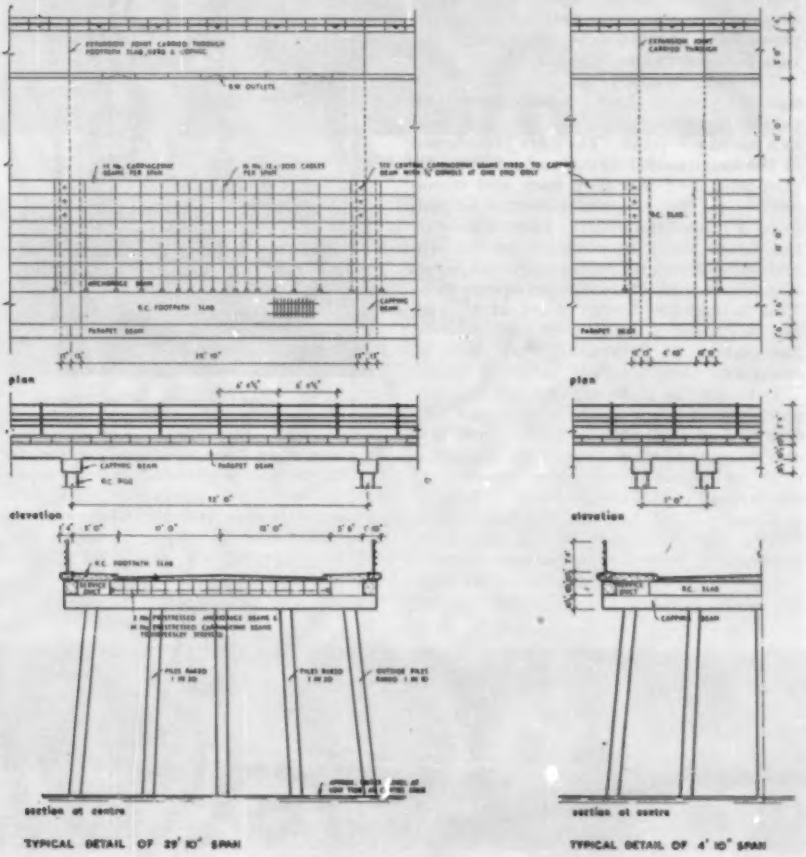



**Fig. 1.—Part Plans and Sections.**

concrete piles driven to hard chalk underlying mud, chalk rubble, and flint. There are twenty-nine spans of 30 ft. and four spans of 7 ft.; the latter are strong-points placed at about the fifth-points of the bridge. Each of the thirty-four piled trestles (*Fig.* 4) supporting these spans consists of five reinforced concrete precast piles under the width of the bridge with a concrete capping beam cast in place.

The piles, 170 in all, are 1 ft. 4 in. square; in each trestle the outer piles have a rake of 1 in 10, the central pile is vertical, and the other two have a rake of 1 in 20. Longitudinal forces are resisted by the four double-pile trestles at the fifth-points. The capping beam is 1 ft. 6 in. deep by 2 ft. 2 in. wide, and carries sixteen prestressed precast deck beams and the two parapet beams.

The deck beams (*Fig.* 5) are 1 ft. 6 in. square with slightly inclined sides to permit mortar to be packed between them in a narrow V-joint. They are prestressed in the longitudinal direction by two 1¼-in. post-tensioned Macalloy bars and transversely by the Freyssinet system to produce a monolithic slab. Twenty-four of the beams have been tested on the site and have shown no defect when subjected to a tensile force of 250 lb. per square inch. Two beams are being tested at the research station of the Cement and Concrete Association to determine losses due to creep and their ultimate strength.

Between the slabs are expansion joints consisting of bitumen and bituminised felt. One end of each slab is fixed to the pile cap by rustless-steel dowel-bars, while the other end is free to move over bituminised felt laid on top of the pile cap.

A space is left between the beams containing the anchorage of the transverse prestressing wires and the parapet beams; this provides a duct for services on each side of the bridge. The footpaths are cast in place over these ducts. The parapet beams are also prestressed and are separated by expansion joints containing compressed rubber sheeting. They are surmounted by a cast stone coping.

**Fig. 3.—Cantilevered Pile Frame.**

The piles and the prestressed beams were precast near the mainland end of the bridge; the casting beds had capacities

**Fig. 2.—View from Mainland End.**

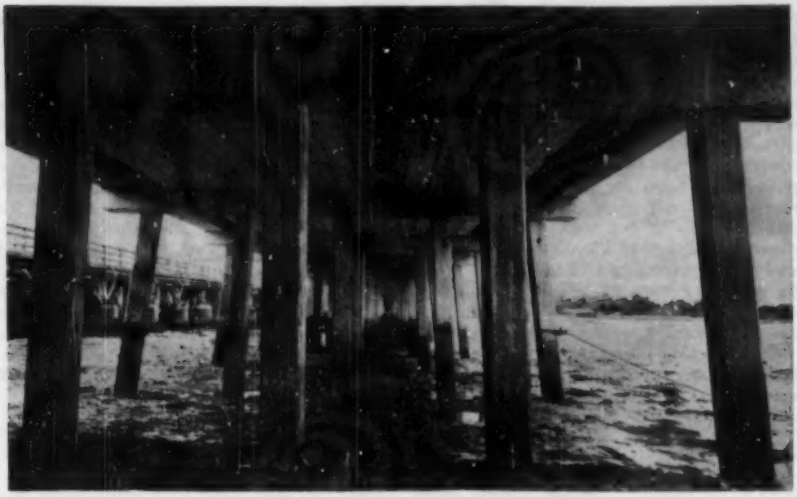


**Fig. 4.—The Underside.**

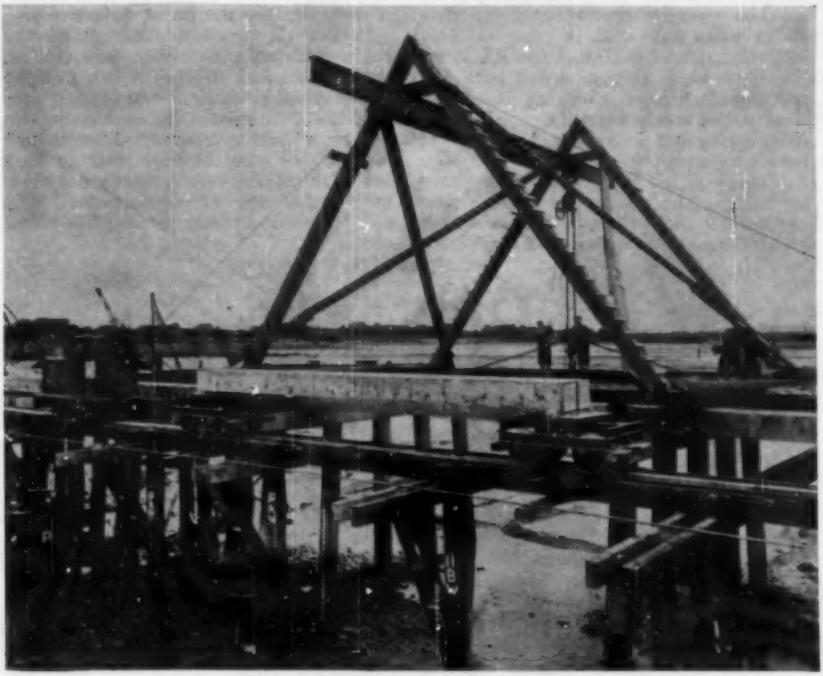


**Fig. 5.—Beams Delivered on Bogies for Erection.**

of twenty piles 80 ft. long and thirty-six beams. The concrete for the prestressed deck beams was specified to have a cube strength of 6000 lb. per square inch at the time of stressing; the specified compressive strength of the piles was 6000 lb. per square inch at seven days, and of the concrete for the capping beams and footpath slabs 2450 lb. per square inch at seven days. A 1 : 3 mixture with a water-cement ratio of 0·3 was used and compacted by internal vibrators. The piles and beams were lifted in the casting yard by a gantry with a capacity of 7½ tons and transported to the bridge by a diesel locomotive on a narrow-gauge railway.

Construction proceeded from the mainland towards the island. Timber staging was erected and the piles driven from a cantilevered frame (*Fig.* 3) which was moved along the staging as work proceeded. The frame was 100 ft. high, and a single-acting 6 tons hammer was used.

The foundations for the embankments were excavated by a 6-in. pump with an hydraulic cutter mounted on a crane barge, and this was supplemented by a drag-line working from the old causeway. Some 5500 cu. yd. of filling were used for the embankments, and the bridge required 2500 cu. yd. of concrete and 350 tons of steel.

The bridge, details of which are given in *Fig.* 1, was designed under the supervision of Brigadier A. C. Hughes, C.B.E., T.D., County Surveyor of Hampshire. The contractors are Messrs. Christiani & Nielsen, Ltd.

## The Status of Engineers.

WE have received the following from Mr. R. B. Macfarlane, Consulting Engineer, of Richmond, Virginia, U.S.A.

"I have been interested in the editorials and articles published in your valuable magazine on the Status of the Engineer. We have been so bombarded with the propaganda that engineering is a profession that nearly everyone now believes that statement is true. It would be heresy for a professional engineer to deny it. However, at the risk of the penalty for that crime, I suggest that young engineers explore the situation free from the influence of propaganda and start with the statement that engineering *per se* is not a profession. Engineers are more likely to attain a professional status if they can see the forest objectively.

"There is another matter that the engineer must not forget. The doctor, the lawyer, and the priest can practise their several professions and enjoy a professional immunity. In engineering no 'practice' will be allowed. The engineer must do or die. It may well be that this is the reason why so many engineers hide behind the corporations and forfeit their opportunity of a professional career."

## New Bridges in India.

IT is thought that a bridge to be built over the Chambal river near Agra will be the longest submersible bridge so far constructed. The bridge will be 2434 ft. long with foundations 60 ft. below low-water and with spans up to 143 ft. This bridge is designed to be submerged to a depth of 27 ft. during monsoons. A road bridge 3300 ft. long in prestressed concrete, with spans 150 ft. long and foundations 75 ft. below low-water, is to be constructed over the Sone river in the Mirzapur district, and is to be completed in fifteen months.

Both bridges are to be designed and built by Messrs. Gammon (India), Ltd.

## Conditions of Contract for Work Overseas.

CONDITIONS of contract for oversea works have been prepared by the Association of Consulting Engineers jointly with the Export Group for the Constructional Industries, and have been approved by the Institution of Civil Engineers. The conditions have as their objective a clear and logical sequence of clauses, the removal of ambiguities, the elimination so far as possible of speculative elements, and a fair distribution of the risks inherent in works executed largely below ground. Provision is made for disputes to be submitted to an arbitrator.

# A Prestressed Building at Southend-on-Sea.

An extension of the factory at Southend of Messrs. E. K. Cole, Ltd. (*Fig.* 1), has an area at ground level 96 ft. square and three upper stories H-shape in plan (*Fig.* 2). The total floor area is 30,500 sq. ft. The outer columns are at 32 ft. centres; the four inner columns are 32 ft. apart in one direction and 46 ft. in the other (*Fig.* 3).

The columns, beams, floors, stair flights, and landings were all precast; only the stair wells, foundations, and ground beams were cast in place. For ease of handling the floors are built with members weighing between 3 cwt. and 5 cwt. and the beams with parts weighing not more than 2 tons, and the heaviest column weighs 2½ tons. There are about 10,000 precast parts in the building.

The factory is designed for a superimposed floor load of 120 lb. per square foot. The floor slabs are formed of hollow members, 6 ft. long by 10 in. deep over the 32-ft. spans and 15 in. deep over the 46-ft. spans, with closed ends. At the ends of the rows of slabs are solid anchorages each the width of two slabs, which form an upper flange to the beams. The beams and columns interlock, and the columns are prestressed.

The foundations of the columns are on clay between 6 ft. and 8 ft. below ground level, and pockets were formed in them to accommodate the precast columns. The

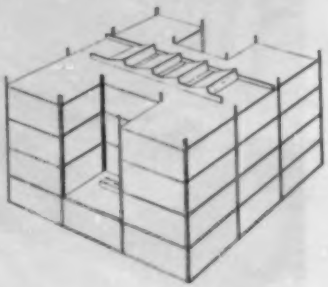


Fig. 2.

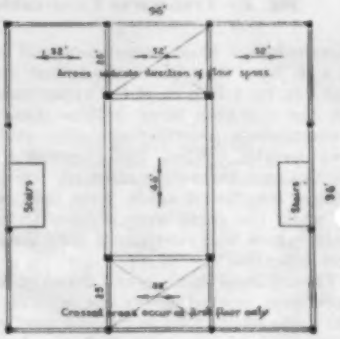



Fig. 3.

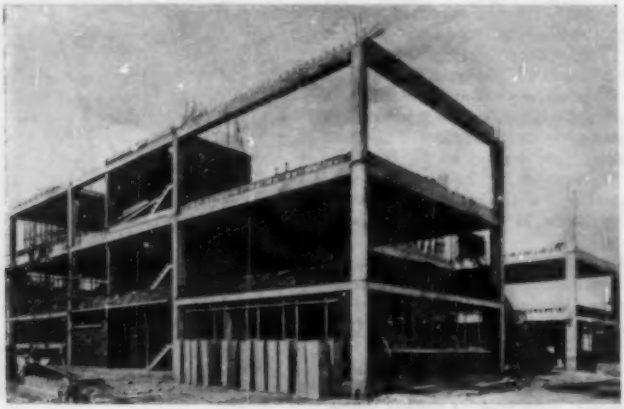


Fig. 1.—View during Construction.

**Fig. 4.—Transverse Floor-cables and Anchorage at Bottom of Column.**

inner columns have a cross-sectional area of 2 ft. by 2 ft. 3 in. in the lowest story and 2 ft. by 1 ft. 9 in. in the upper stories. All the columns have hollow cores to accommodate prestressing cables and to save weight. When the columns were erected and the cables inserted, the projecting lengths of cable were held in a jig while the cores were filled with concrete, which was compacted with immersion vibrators.

The columns, beams, and floors of each story were erected before the next higher story was built. While the columns were being erected the parts of the beams were assembled, jointed, and prestressed to form beams 25 ft., 32 ft., or 46 ft. long. The beams were erected by two mobile cranes and bedded at the ends in stiff mortar. Temporary adjustable steel props were used to support the beams while the floor slabs were lifted into position by a hoist and assembled into slabs on tubular-steel scaffolding. The end anchor-blocks are slotted to fit between shear connectors on the beams. Special hollow members, with holes for services to pass from floor to floor, were included where necessary.

Two lines of hollow slabs were placed so that the scaffolding acted as centering for the joints between the slabs. Before these joints were filled with mortar, the transverse prestressing cables were laid in a plastic tube across the width of the building and kept in position by precast blocks between each row of hollow slabs. These blocks also ensured that the wires were maintained at the required curvature. The prestressing force was applied to the two rows of hollow slabs when the 2-in. mortar joints between them were two days old. The 3-in. gaps between the hollow slabs were then filled with mortar, and two days later the transverse cables were tensioned.

When the floor was fully prestressed,

**Fig. 5.—Placing a Column Anchor-block.**

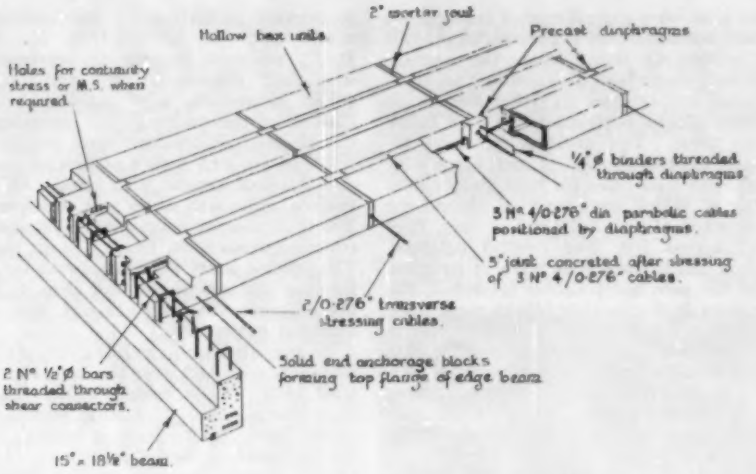

2" mortar joint
Hollow box units
Precast diaphragms
Holes for continuity stress or M.S. when required.
¼" ø binders threaded through diaphragms
3 N° 4/0·276" din parabolic cables positioned by diaphragms.
5" joint concreted after stressing of 3 N° 4/0·276" cables.
2/0·276" transverse stressing cables.
Solid end anchorage blocks forming top flange of edge beam
2 N° ½" ø bars threaded through shear connectors.
15" × 18½" beam.

**Fig. 6.**

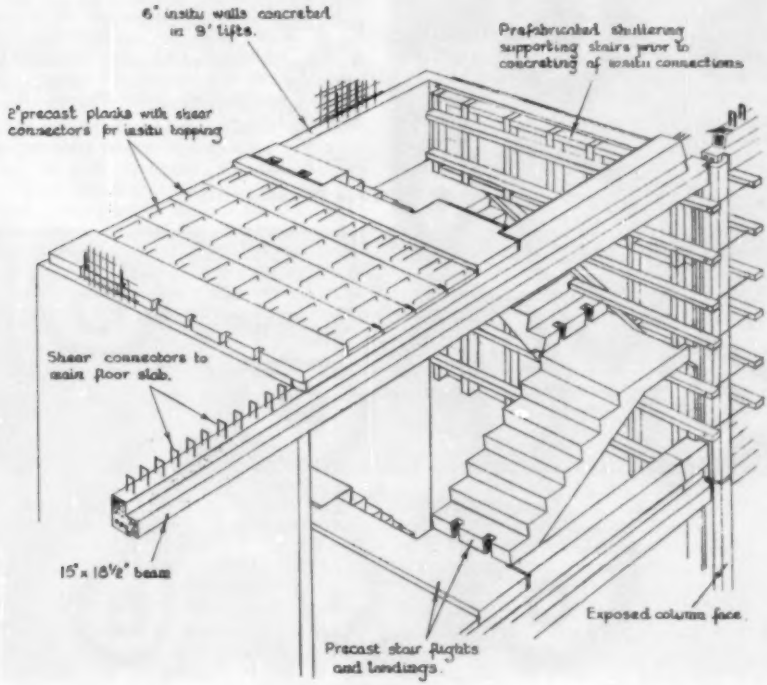

6" insitu walls concreted in 9' lifts.
Prefabricated shuttering supporting stairs prior to concreting of insitu connections
2" precast planks with shear connectors for insitu topping
Shear connectors to main floor slab.
15" x 18½" beam
Precast stair flights and landings.
Exposed column face.

**Fig. 7.**

two ¾-in. bars were threaded through the shear connectors on the beams to provide a permanent fixing with the anchor-blocks; these bars also connect adjacent blocks, and recesses on either side of the anchor-blocks positioned the bars below floor level. The dividing portions between the two recesses of each block were cast with four holes for continuity cables (*Fig.* 4), which were inserted around the perimeter of the building at each floor and across the four central columns. When the locking bars were in position, and the continuity cables tensioned, the recesses in the anchor-blocks were filled with concrete.

The roof is composed entirely of hollow slabs 10 in. deep, and the construction methods were the same as those used for the floors. On the main roof north-lights will be installed for a drawing office.

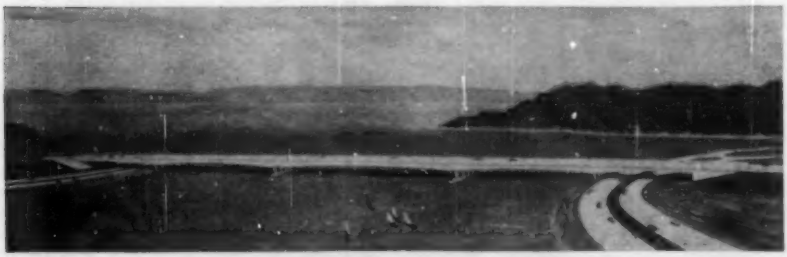
A precast block was placed on the top of each column (*Fig.* 5) to serve as an anchor for the prestressing wires extending through the column. This also served as the bottom anchor for the wires extending through the next length of column. A block of in-situ concrete was then placed over the anchor-block to raise the junction up to floor level and to provide an anchor for the continuity cables from the beams (*Fig.* 6). The P.S.C. one-wire system of prestressing was used throughout, generally using cables comprising four 0·276-in. wires. Guides for the cables at the junctions of the beams and columns were precast.

There are two flights of precast stairs and landings around lift shafts. All the outside walls will be in 9-in. brickwork. The staircases are supported by reinforced concrete walls 6 in. thick cast in place. The precast units were supported by the internal shutters of the wall (*Fig.* 7) and the concrete was placed in 9-ft. lifts and vibrated externally.

To provide a uniform line extra precast members were laid over the beams at the stair wells. These members also ensured that the required floor level was maintained both for the precast landing and for the beams at the open stairway. Continuity prestressing was applied through the sections in the same way as for the floor-slab anchor blocks.

The building was designed by Messrs. E. K. Cole, Ltd., in conjunction with A. & C. Buildings, Ltd., who supplied the precast units and erected the frame. The general contractors were Messrs. A. J. Arnold, Ltd.

## A Prestressed Bridge in Australia.



THE Government of Western Australia had approved proposals for a highway bridge, to be completed in the next three years, across the Swan river at Perth. The bridge, which is to be of prestressed concrete, will have a carriageway 70 ft. wide and two footpaths each 10 ft. wide. The length between abutments will be 1100 ft., in five spans of which the longest will be 320 ft.

The design has been prepared by the Government's consulting engineers, Messrs. G. Maunsell & Partners, of London, who have had the advice of Sir William Holford & Partners on the appearance of the bridge, of Mr. C. S. Chettoe, formerly bridge engineer of the British Ministry of Transport, and also of Mr. E. W. H. Gifford on the prestressed concrete work.

# Prestressed Bridge in Derbyshire.

A BRIDGE (*Fig.* 1) at Beighton, Derbyshire, is built on a site that was clear of the river Rother, which was afterwards diverted to a new course excavated under the new bridge. The foundations of the abutments are on clay 7 ft. below the bed of the river, and were built within steel sheet piling. The abutments and the wing-walls of the approaches are of reinforced concrete counterfort construction. At the fixed end the beams rest on cast-steel plates and at the free end on cast-steel roller bearings. A reinforced concrete slab 9 in. thick was placed under the bridge at the level of the river. A mixture of 1 : 5·8 by weight with a water-cement ratio of 0·45 was used for the abutments and wing-walls; the average compressive strength at seven days was 4150 lb. per square inch. Sulphate-resistant Portland cement was used for all parts of the substructure.

The bridge is at an angle to the river of 23 deg.; the carriageway is 22 ft. wide and there are two footpaths 7 ft. wide. The bridge consists of nine prestressed longitudinal beams with a span of 67 ft. 5 in. and a clear span between abutments of 65 ft. 2 in. There are five intermediate beams of I-section, 3 ft. 4 in. deep, at 5-ft. centres; the top flanges are 6½ in. thick and form the deck of the bridge; the bottom flanges are 2 ft. 6 in. wide and 6 in. thick. The two outer beams on both sides (*Fig.* 2) are connected at their centres by a slab and form a trough for gas mains and other services. The two outer beams are 4 ft. 8 in. deep with flanges 1 ft. wide at the top and bottom. The seven inner beams are connected by slabs 6 in. thick at 15-ft. centres. The centroids of all the beams are in the same plane across the bridge.

The shuttering for the beams was erected on the ground slab. The deck is reinforced transversely with two layers of ½-in. bars at 4-in. centres and longitudinally with ½-in. bars at 12-in. centres.

**Fig. 3.—Prestressing Cables in Beam.**

**Fig. 1.**

The ends of the beams are reinforced with ¼-in. and ⅜-in. bars. Prestressing was applied by cables of twelve wires of 0·276 in. diameter in flexible steel tubes; six cables are used in the main beams (*Fig.* 3), five in the inner beams, and three in the outer beams.

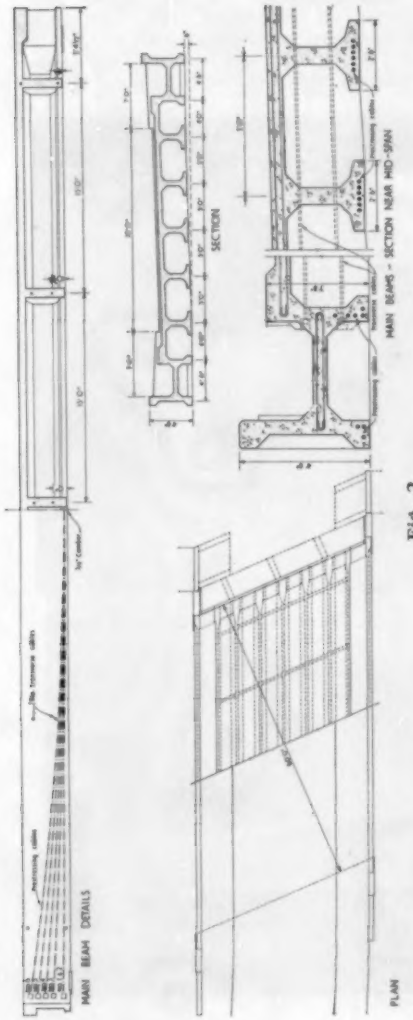



Fig. 2.

The bridge was designed for the Ministry of Transport Standard Loading. The specified compressive strengths for the beams were 6000 lb. per square inch minimum and 7000 lb. per square inch average at twenty-eight days. The lowest cube strength obtained was 6050 lb. per square inch and the average 7800 lb. per square inch. A 1 : 4 mixture by weight and a water-cement ratio of 0·4 were used, and compaction was by immersion vibrators.

The cost of the bridge was £15,300. Mr. S. Mayhew, O.B.E., is the County Surveyor of Derbyshire, and the contractors were Messrs. Ruddock & Meighan, Ltd.

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## A Dome of 290 ft. Diameter.

In a paper presented to the annual convention of the American Concrete Institute held in February last, Mr. J. J. Closner describes a dome roof of 290 ft. diameter over a sports stadium at Havana, Cuba. It is believed that this is the largest reinforced concrete dome constructed to date with a prestressed edge beam. The roof consists of a dome 6 in. thick at the middle and increasing in thickness to 12 in. at a distance of 33 ft. from the edge where it is connected to a ring-beam 3 ft. 4 in. by 5 ft. 4 in. in cross section. The edge-beam is supported on 24 columns at intervals of 38 ft. The columns are 8 ft. 10 in. high and are hinged to allow for radial movement of the edge-beam.

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## Prestressed Roads.

Measurements made by the Road Research Board suggest that the restraint of the subgrade in the longitudinal direction when a prestressed road is subjected to daily changes of temperature is about 1½ times the weight of the slab.

In the case of prestressed road slabs several hundred feet long, changes of temperature may cancel most of the prestressing force.

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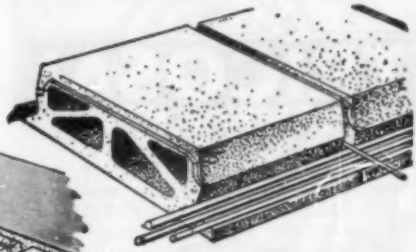

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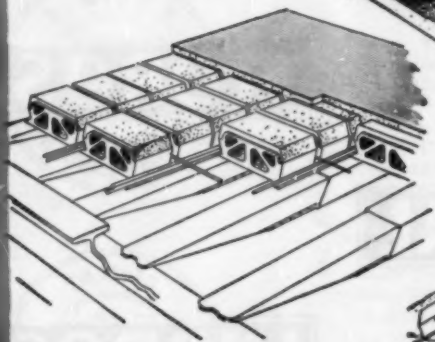
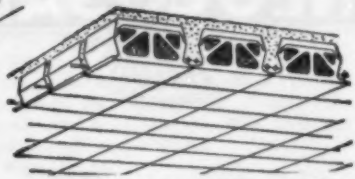


Showing Two-Way Reinforcement and Hollow Concrete Blocks laid on Trianco Telescopic Centers.



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# Warehouse at Kilmarnock.

A NEW warehouse (*Fig.* 1) recently built at Kilmarnock for Messrs. John Walker & Sons, Ltd., has storage space for 1,400,000 gallons of whisky on five floors (each with an area of 3300 sq. yd.), and a blending annex of equal height but having only two floors.

The warehouse is of flat-slab construction with splay-headed rectangular columns and the annex of beam and slab construction. The floor loading is 3 cwt. per square foot. The flat slabs are 9 in. thick at the middle strips, with dropped panels at the columns. The walls have beams at each floor level, and are filled with 14-in. solid brickwork. The floors have a granolithic finish.

A reinforced concrete conveyor bridge on top of the building has a clear span of 60 ft. and is 9 ft. wide; the main beams, which form the side walls, are 11 in. thick by 10 ft. deep at the supports tapering to 8 ft. 9 in. deep in the middle third of the span; the depth was controlled by the difference in levels of the floors to be served.

The bottling hall and materials store comprise four structures separated by expansion joints and founded on cast-in-situ piles. The bottling hall is a single-story structure, with a prestressed barrel-vault roof comprising five north lights (*Fig.* 2), having a clear floor area of 105 ft. by 176 ft.; a railway loading

**Fig. 1.—Main Elevation.**

**Fig. 2.—North-light Roof over Bottling Department.**

platform extends the full length of one side and is covered with a cantilevered canopy. This roof is believed to be the first of its kind in Scotland, and is prestressed by the Magnel-Blaton system. Each north-light has a span of 36 ft. and a rise of 31 ft. 9 in. at the apex. The interior edge beams are L-shaped in cross section and 6 ft. deep by 2 ft. 9 in. wide at the base; the ribs and flanges are 8 in. thick. The vault is 7½ in. thick at the supports and in the line of the prestressing cables; elsewhere it is 3 in. thick. The apex of the vault is supported on reinforced concrete columns at about 7 ft. similar cable follows a parabolic curve throughout the length of the beam, approaching the lower cable at mid-span. The calculated extension of the wires in the edge-beam was 6 in. and in the shell 6¼ in.

The inner surface of the shell was sprayed with two coats of vermiculite-asbestos finished with anti-condensation paint. The external finish is canvas impregnated and coated with bitumen laid directly on the concrete.

The roof beams in the bottle-washing house span 27 ft. by 3 ft. deep, and support a concrete roof slab 4 in. thick.

**Fig. 3.—The Recreation Room.**

centres built on the edge-beam of the succeeding vault; these columns form the mullions for the glazing. At the end of each shell is a curved beam 2 ft. 6 in. deep by 9 in. wide. Each shell is supported at its four corners by concrete columns 1 ft. 6 in. wide in one direction and tapering from 2 ft. 9 in. at the level of the beam to 1 ft. 9 in. at the base.

The upper edge of the shell is prestressed with three cables each comprising sixteen wires of 0·242 in. diameter. At the bottom of the shell three such cables are arranged in parabolic curves. One cable comprising forty-eight 0·276-in. wires is placed in the bottom of the vertical part of the edge-beam, and a

The canteen building has reinforced concrete frame, floors, and roofs. A recreation hall (*Fig.* 3) over the canteen has a single-span barrel-vault roof 50 ft. by 74 ft. in area and with a rise of 6 ft. 7 in. at the crown. The thickness at the crown is 2½ in., thickening to 9½ in. at the edge-beams, which are supported on six reinforced concrete columns. The edge-beams are 3 ft. deep by 9 in. thick.

The consulting engineers for the reinforced concrete were Considère Constructions, Ltd., and for the prestressed shell roofs the consultants were Stressed Concrete Design, Ltd. The main contractors were Messrs. Melville, Dundas & Whitson, Ltd.

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# Motor Roads in the U.S.A.

**Through Road and Access Roads in Los Angeles.**

**Two-level Road with Garages under at Seattle.**

The above illustrations are taken from papers submitted to the Conference on Urban Motorways held in London recently under the auspices of the British Road Federation.

# A New System of Flooring.

A SYSTEM of flooring in use on the Continent, and which it is stated will soon be available in this country and the U.S.A., comprises partly precast beams and hollow precast blocks (*Fig.* 1).

The precast beams include a partly-projecting lattice of sheet steel as shown in *Figs.* 2 and 3. Reinforcement bars are attached by clips to the lower part of the lattice (*Fig.* 2) and are embedded in a precast beam 4¾ in. wide by about 1¾ in. deep. Hollow precast blocks, made with dense or lightweight aggregate, are placed between the beams by which they are supported (*Fig.* 3). The space between the blocks is then filled with concrete to form an inverted T-beam.

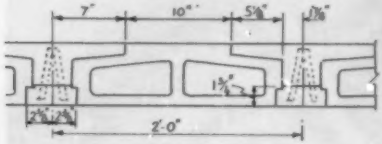


**Fig. 1.**

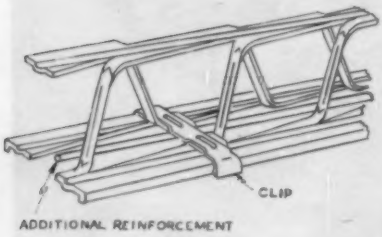


**Fig. 2.**

**Fig. 3.—Floor during Erection.**

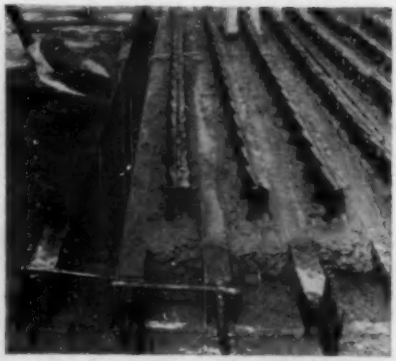

**Fig. 4.—Making the Beams.**

The strength of the floor may be varied to suit the span and the imposed load by varying the amount of reinforcement, the spacing of the beams, and the depth of the blocks and topping.

The sheet steel is supplied in strips 40 ft. long cut to the required pattern, and opened out at the site by a hand-operated machine to form the lattice shape. Moulds for forming the precast beams can be conveniently formed of steel channels laid at the required distance apart on a prepared base (*Fig.* 4).

This system, known as the "Omnia" floor, is represented in this country by the Alexandria Trading Corporation, Ltd.

### REUNION DINNER.

A reunion dinner for past and present students of the D.I.C. Concrete Technology Course will be held on Thursday, 6 December, at City and Guilds College. Former students should write to Professor Baker for further information.

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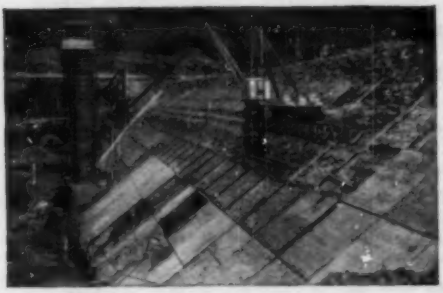

*Photograph by permission of The North of Scotland Hydro-Electric Board. Contractor: Richard Costain Ltd. Consulting Engineers: Sir William Halcrow & Partners. Contract: Garry Hydro Scheme, Quoich Dam, Scotland. In situ cast facing slabs—surface processed.*

*Contractor: Sir Lindsay Parkinson & Co. Ltd. Consulting Engineers: J. D. & D. M. Watson, M.M.I.C.E. Contract: Filter tanks at Unstead Sewage Works for Borough of Godalming. External processing of walls.*

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Nor is this all; for it has been found that curing precautions are no longer so necessary and there is no perceptible shrinkage at the construction joints.

Precast units may be lifted from their moulds within a few hours *without handling steel* by means of vacuum lifters.

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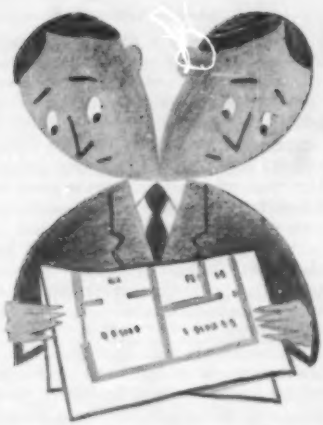

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Flooring and Flooring Materials. By W. J. Warlow. Technical Institute, Southways, Bognor. November 15. 7 p.m. Also at Technical College, Bell Street, Wakefield. November 27. 7.15 p.m.

Dampness in Buildings. By J. P. Latham. Technical College, Hunnyhill, Newport, Isle of Wight. November 19. 7 p.m.

Powered Hand Tools. By A. F. Coare. Lyceum, Union Street, Oldham. November 19. 7.30 p.m.

R.I.B.A. Form of Contract. By J. S. Daniel. College of Technology, Byron Street, Liverpool. November 21. 7.15 p.m.

Problems of Plastering and Rendering. By. E. L. Westbrook. Gas Showrooms, Town Hall Extension, Manchester. November 22. 7.15 p.m. Also by L. A. Ragsdale. Technical College, Kingsway, Scunthorpe. November 28. 7.15 p.m.

Common Defects in Building. By H. M. Llewellyn. Windsor Restaurant, St. John's Street, Perth. November 22. 7.15 p.m.

Introduction to Prestressed Concrete. By R. C. Blyth. Grosvenor Museum, Grosvenor Street, Chester. November 23. 7.30 p.m.

Control of Concrete Quality on Sites. By R. A. Kenny. College of Further Education, Warwick New Road, Leamington. November 26. 7.15 p.m.

Building (Safety, Health and Welfare) Regulations, 1948. Technical College, Worsley Bridge Road, London, S.E.26. November 26. 7 p.m. Also by J. B. Bloor. Technical College, Newstead Road, Weymouth. November 27. 7.15 p.m.

Development Trends in Building Plant. By W. R. Matthews. City Chambers, Edinburgh. November 27. 7.15 p.m. Also at Town Hall, Thurso. November 29. 7.15 p.m.

Essentials of Good Concreting. By E. E. H. Bate. Technical College, Park Square, Luton. November 28. 7.30 p.m.

Arbitration and Awards. By John J. Clarke. Technical College, Wulfruna Street, Wolverhampton. November 28. 7.15 p.m.

### Prevention of Cracks by the Use of Aluminium-alloy Reinforcement.

A PATENT (No. 80418) granted in Holland to N. V. Schokbeton relates to the prevention of cracks in concrete by the use of metal reinforcement such as aluminium-alloy that has a greater coefficient of shrinkage than concrete. According to the patent specification, the concrete would be cured in steam at high temperature, so that on cooling the metal reinforcement would shrink more than the concrete and so produce compression in the concrete.

---

### Proposed By-pass Road at Doncaster.

THE Ministry of Transport announces that it is proposed to start the construction of a road to by-pass the city of Doncaster within the next three years. The cost is estimated to be £5,000,000. The road as now planned will be fifteen miles long with two carriageways each 24 ft. wide, and will be restricted to the use of motor traffic only. It will pass under nineteen intersecting roads and will be carried over the river Don by a bridge about 80 ft. long; altogether there will be twenty-six bridges, including two over railways and four under railways.

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### Lightweight Concrete.

THE following is an extract from the Report of the Building Research Board for the year 1955.

"The work on the manufacture of a lightweight aggregate from pulverized fuel ash, carried out on behalf of the Central Electricity Authority, has continued during the year and has aroused a good deal of interest. Not all the full-scale production problems have been solved, but production on a pilot scale has been satisfactorily achieved. The stimulus given by the Station's investigations has led to development work by prospective manufacturers.

"This work is an outcome of the Station's interest in lightweight concrete extending back for nearly thirty years. At the time investigations were started, clinker or breeze and imported pumice were the only lightweight aggregates available. Now a range of lightweight aggregates are known and can be used with confidence, and aeration either by foam or by chemical reaction has provided a further means of making lightweight concrete. The Station's systematic investigations have yielded much of the knowledge required to further these developments and the use of the products in building."

The wording of these paragraphs seems to be unfortunate, for it is not likely that the Board wishes to convey the idea that the lightweight concretes that have come into use in this country during the past thirty years originated at the Building Research Station. The truth is that every one of these lightweight concretes and aggregates—foamed slag, expanded clay and shale, vermiculite, "no-fines" concrete, pulverised-fuel ash, and cellular and aerated concretes—were in use abroad before they were brought to this country.

---

### Reinforcement in Concrete Roads.

EXAMINATION of an experimental road built by the Ministry of Transport in the year 1933 shows that reinforcement placed in a single layer is most effective in controlling cracks if it is near the top, and that there was no advantage in having the same weight of reinforcement in two layers.

**MISCELLANEOUS ADVERTISEMENTS.**

*Situations Wanted, 4d. a word : minimum, 7s. 6d. Situations Vacant, 5d. a word : minimum, 10s. Other miscellaneous advertisements, 5d. a word : 10s. minimum. Displayed advertisements, 35s. per column inch. Box number 1s. extra.*

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## SITUATIONS VACANT.

SITUATION VACANT. E. J. COOK & Co. (ENGINEERS), LTD., require an experienced detailer for reinforced concrete structures. Interesting work and good prospects for competent man. Five-days' week, pension scheme and luncheon vouchers. Apply to 54 South Side, Clapham Common, London, S.W.4.

SITUATION VACANT. Consulting structural and civil engineers require an engineering assistant with at least 5 years' office experience since Graduateship and National Service, to supervise the design and detailing of reinforced concrete structural frameworks and foundations. Salary £750–£900 according to age, qualifications and experience. Superannuation scheme and luncheon vouchers. Apply ANDREWS, KENT & STONE, 60–66 Wardour Street, London, W.1.

SITUATION VACANT. Civil engineering draughtsman required for work in London office of large civil engineering contractors. Work of varied nature, with scope for initiative and advancement. Commencing salary £600–£800 depending on experience. Five-days' week and luncheon vouchers. Pension scheme operates. Box 4328, CONCRETE AND CONSTRUCTIONAL ENGINEERING, 14 Dartmouth Street, London, S.W.1.

SITUATIONS VACANT. Senior reinforced concrete designers wanted by leading reinforced concrete engineers and contractors. Must be fully conversant with Code of Practice, L.C.C. Bye-Laws, and able to design light-framed structures from estimating stage to final details. Five-days' week. Pension scheme. Progressive position. Starting salary from £900 upwards according to ability. This year's holiday arrangements honoured. Juniors also required, similar conditions. Write Box 4172, CONCRETE AND CONSTRUCTIONAL ENGINEERING, 14 Dartmouth Street, London, S.W.1.

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SITUATIONS VACANT. Senior reinforced concrete designers required. Must be experienced in the design of foundations and structures. Maximum assistance given in obtaining accommodation. Pension scheme. ASHMORE, BENSON, PEASE & Co., Stockton-on-Tees.

SITUATIONS VACANT. Reinforced concrete designers and detailers required for work on a variety of interesting projects. Five-days' week of 35 hours. Guaranteed bonus. Apply in writing to A. C. WILSON & PARTNERS, LTD., Design House, The Mall, Ealing, London, W.5, or telephone Ealing 9843 for an appointment.

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SITUATIONS VACANT. KAYLOR & PICK, consulting engineers, require in their London office senior and junior detailers and draughtsmen for reinforced concrete work. Positions offered are permanent, and the work is varied and interesting. There is scope for advancement for men with ambition. Five-days' week. Apply to 42 Ferncroft Avenue, London, N.W.3.

SITUATIONS VACANT. Reinforced concrete designer-detailers required in Westminster consulting engineer's office. Minimum qualification : degree or H.N.C. Staff pensions scheme, luncheon vouchers, alternate Saturdays. Salary according to experience and qualifications. Apply in writing, giving full details of age and experience, to J. D. & D. M. WATSON, 18 Queen Anne's Gate, Westminster, S.W.1.

SITUATION VACANT. Reinforced concrete engineers require a designer-draughtsman capable of carrying out complete design and detailing of reinforced concrete structures with minimum supervision, for their South East Manchester office. Canteen available and staff superannuation scheme in force. Reply, stating age, experience, and salary required. Box 4325, CONCRETE AND CONSTRUCTIONAL ENGINEERING, 14 Dartmouth Street, London, S.W.1.

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*(Continued on next page.)*

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*(Continued from previous page.)*

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SITUATION VACANT. Assistant resident civil engineer required to supervise extensions to our works in North Kent. Age 24 to 30. Must have suitable qualifications, and some site experience and design experience of reinforced concrete work. Apply, with full details of age, training and experience, to CHIEF ENGINEER, A.P.C.M., LTD., Portland House, Tothill Street, London, S.W.1.

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SITUATIONS VACANT. Reinforced concrete detailing draughtsmen required. Excellent opportunity in expanding company. Full details to Managing Director, Speediform Structures, Ltd., Shifnal, Salop.

SITUATION VACANT. Estimator required for reinforced concrete light frame structures, hollow tile floors, etc. Five-days' week. Pension scheme. Apply in writing, giving brief details of experience and salary required, to The Helical Bar & Engineering Co. Ltd., 82 Victoria Street, London, S.W.1.

SITUATIONS VACANT. Experienced draughtsmen with sound knowledge of reinforced concrete structural framework are required for the London office of R. E. Eagan, Ltd. Good salary. Five-days week. Apply in writing to 167 Victoria Street, London, S.W.1.

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**Reinforced Concrete Designers...**

**to join the London staff of**

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There are opportunities for Reinforced Concrete Designers in their New London Office at 54 Grosvenor Street, equipped with controlled heating and ventilation and canteen. Five day week — 37½ hours — Pension Fund. Salaries are reviewed annually. Designer-Detailers with good experience will be offered salaries of £750 to £950 per annum, and Detailers with some design experience, up to £750 per annum. They also have a few openings for Student Apprentices of good educational standard and for Students who have just completed the Higher National Certificate Course.

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## SENIOR REINFORCED CONCRETE DESIGNER

Applications are invited by a company situated in Essex and specialising in the design and construction of grain storage silos. Qualified man preferable but not essential. Excellent prospects for right man. Pension scheme. Possibility of directorship after qualifying period. Forward full details, and salary range required, to Box 4328, Concrete and Constructional Engineering, 14 Dartmouth Street, London, S.W.1.

SITUATION VACANT. Detailer-draughtsman required for varied reinforced concrete work in sub-contractors' head office opposite Euston Station. Permanent, progressive, and superannuated post. Five-days' week. Telephone for appointment. EUS. (London) 4096.

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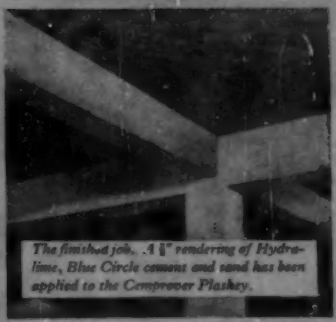

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